THE LARGE-DISDROMETER EXPERIMENT (LDE)
&
UCLM'S X-BAND RADAR (T-REX) STATUS

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+

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[thanks to Walt Petersen, Mathew Schwaller, David Wolff,
Ziad S. Haddad, Chris Kummerow, Ali Tokay, and Ramesh Kakar]

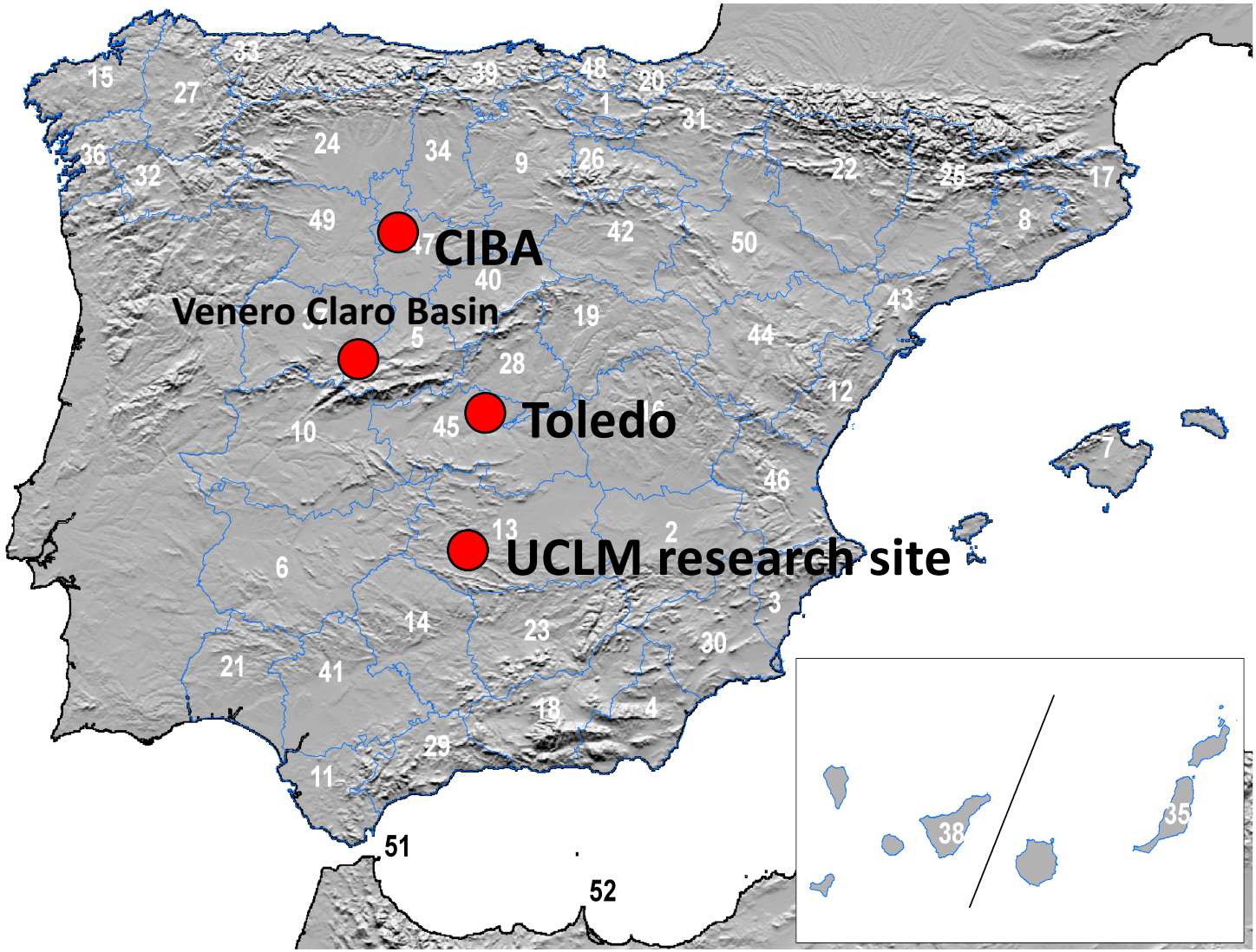
UCLM's Disdrometers

2 Thies

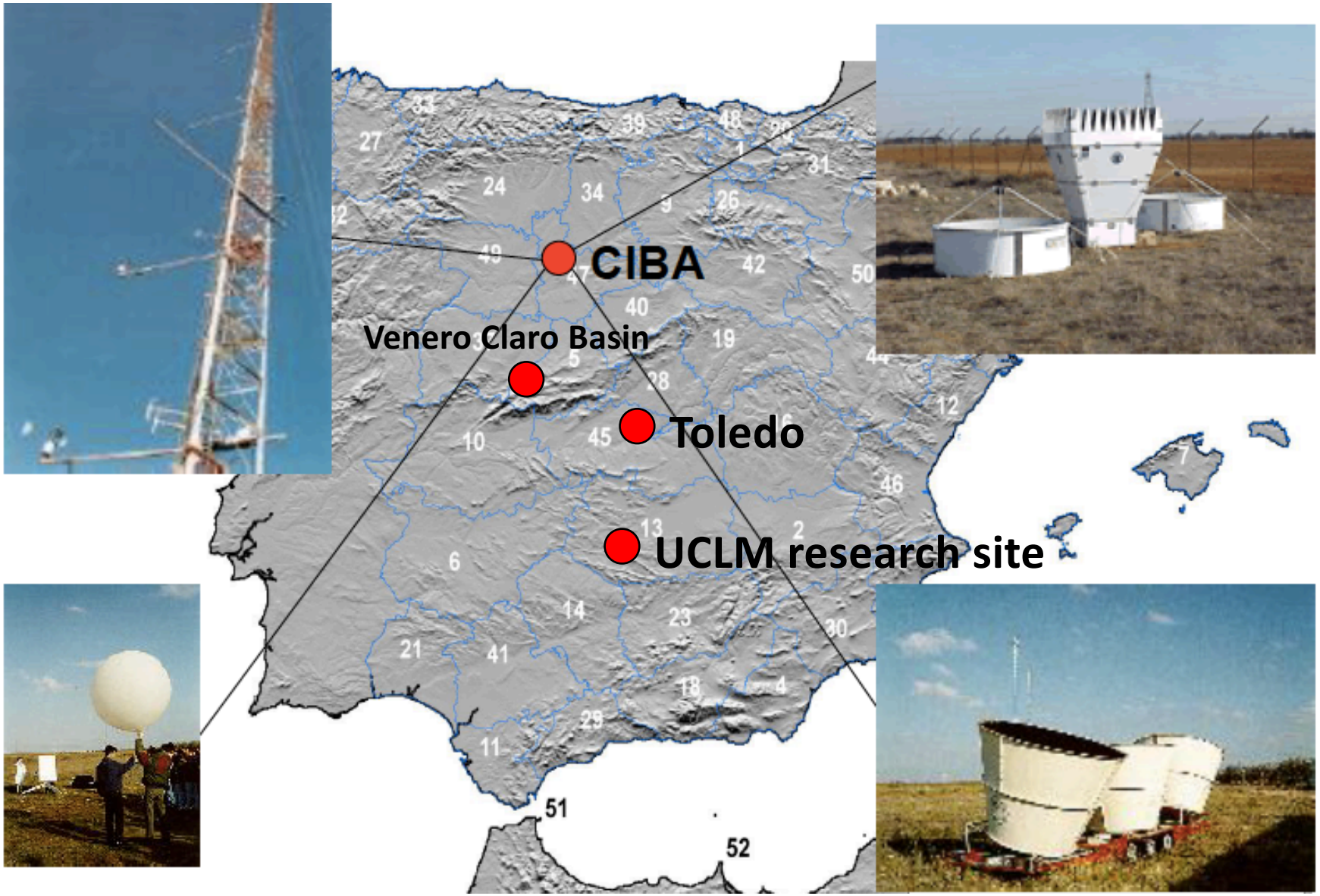
16 Parsivel-1

8 Parsivel-2

Several experiments


CIBA
Venero Claro Basin
Toledo
UCLM research site

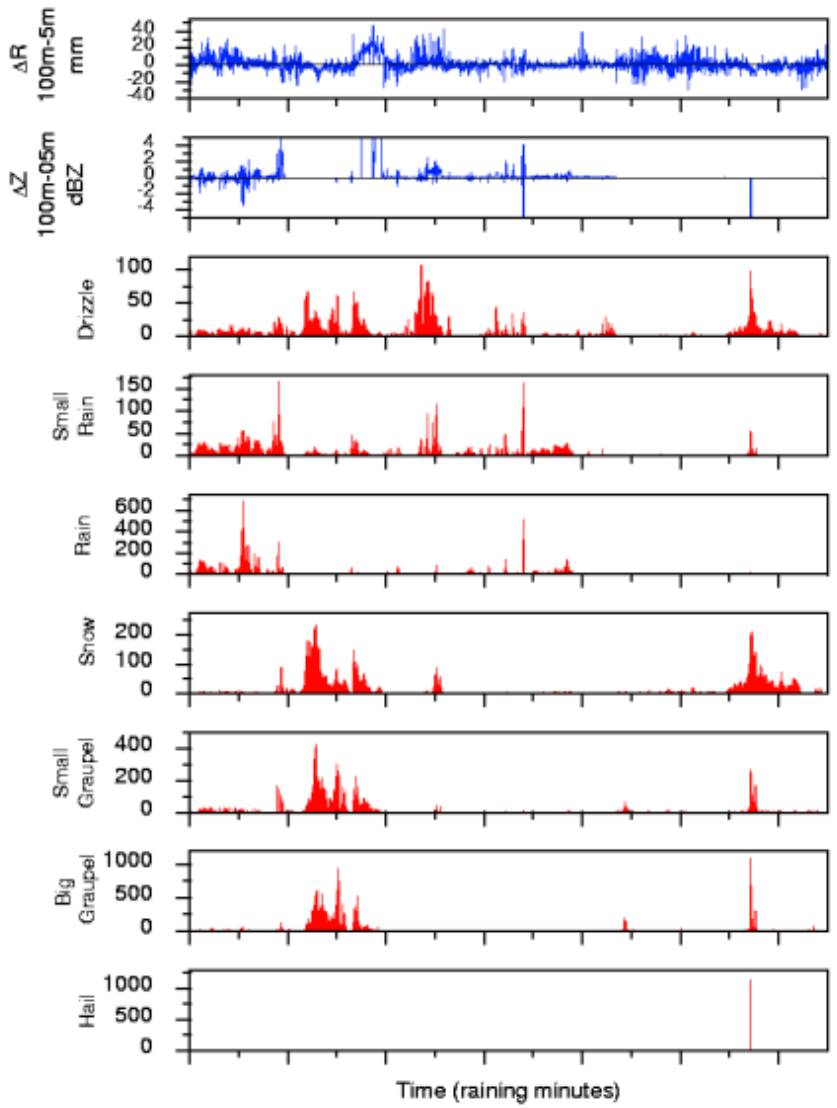
CIBA
Venero Claro Basin
Toledo
UCLM research site
51
52


CIBA
Venero Claro Basin
Toledo
UCLM research site


Thies disdrometers on top of a
100m meteo tower and at 5m
CIBA

Some experiments:

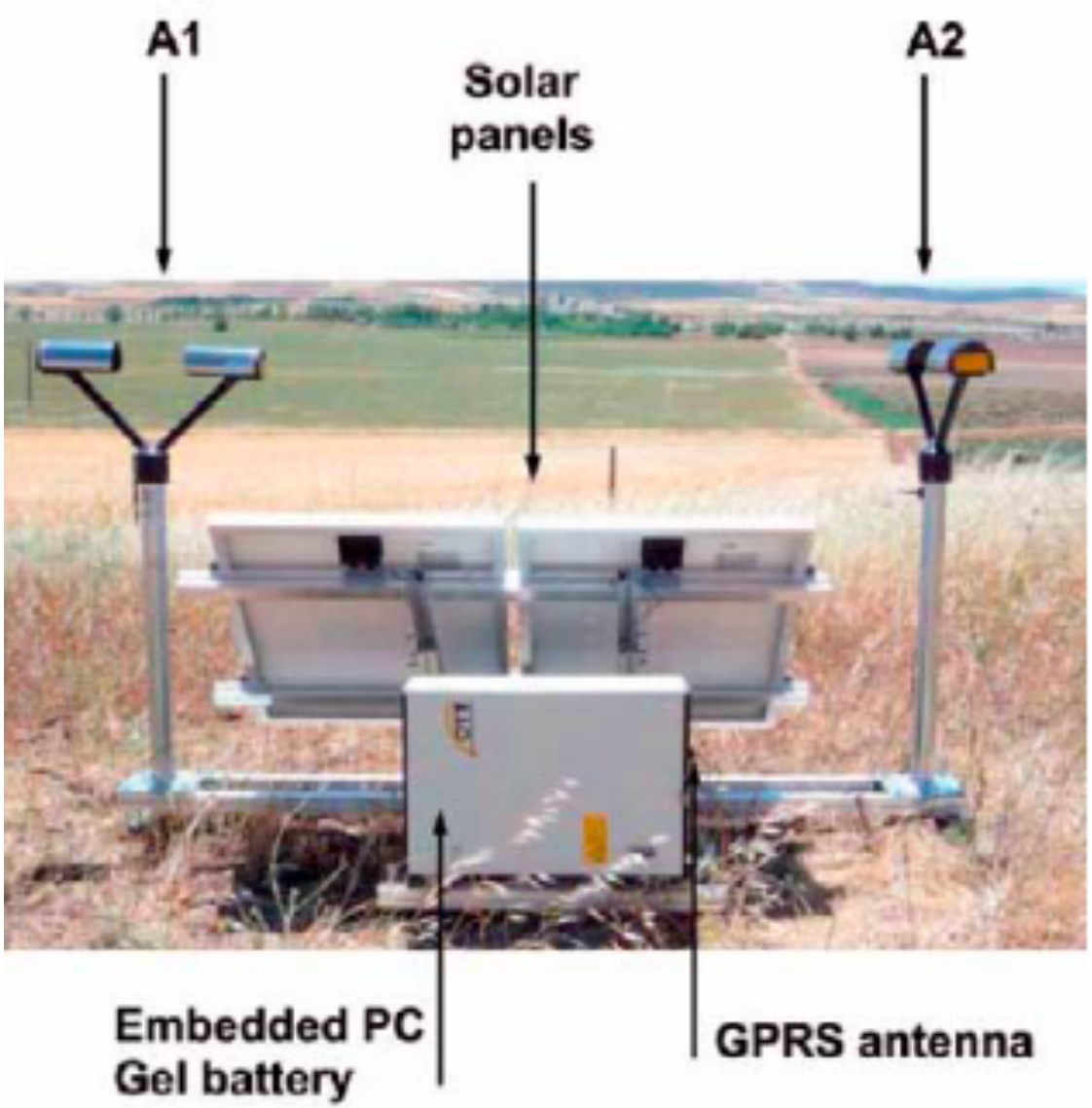
- Comparing 100m-5m measurements for the raining events
- Just a few episodes
- Database still to be exploited



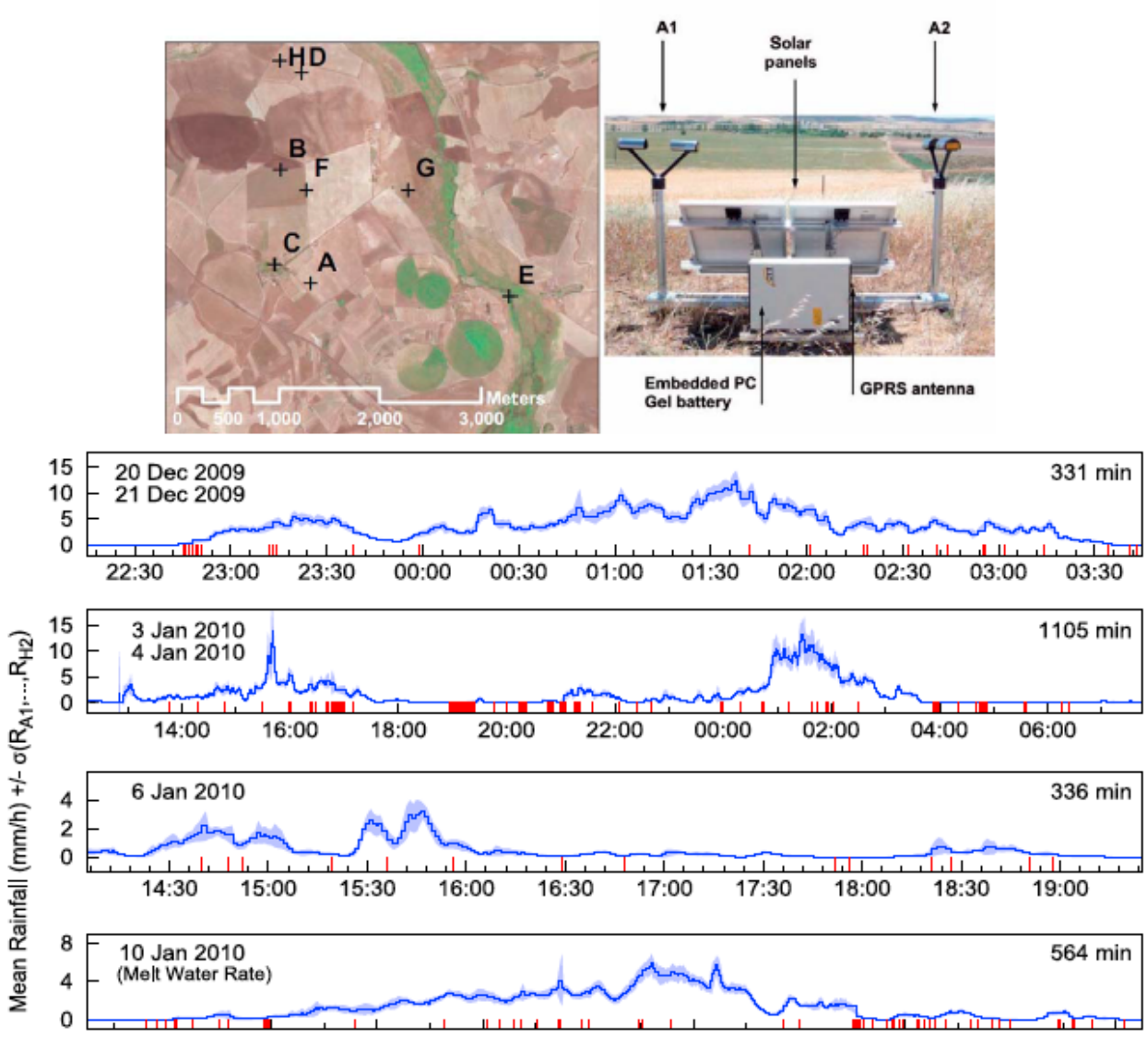
2009 PMM Science Team Meeting, Salt Lake City, UT

The UCLM D-Array

Made of 9 times this dual setup (18 Parsivels)

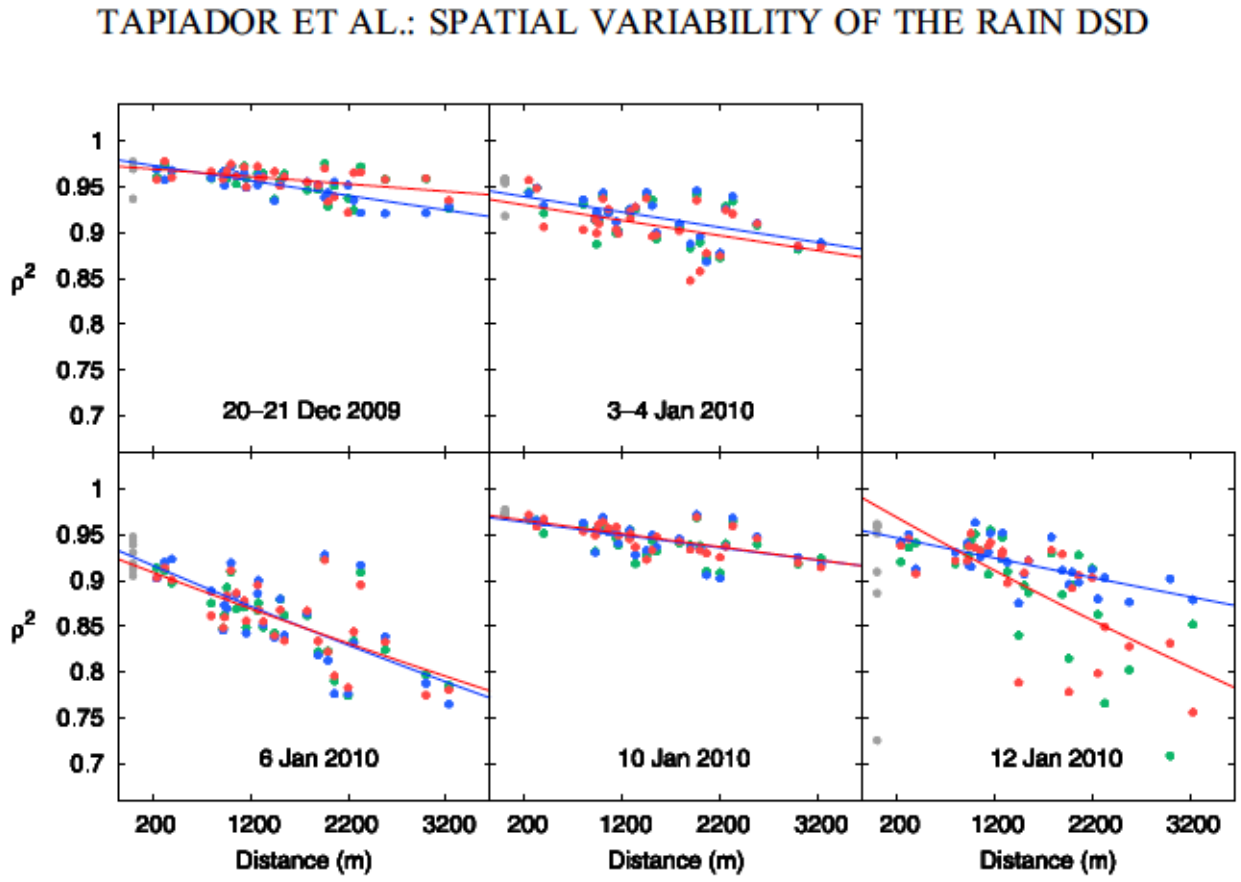


First setup, 2009



F. J. Tapiador; R. Checa; M. de Castro. 2010.
An experiment to measure the spatial variability of rain drop size distribution using sixteen laser disdrometers.
GEOPHYSICAL RESEARCH LETTERS. 37

Reflectivity (Z)



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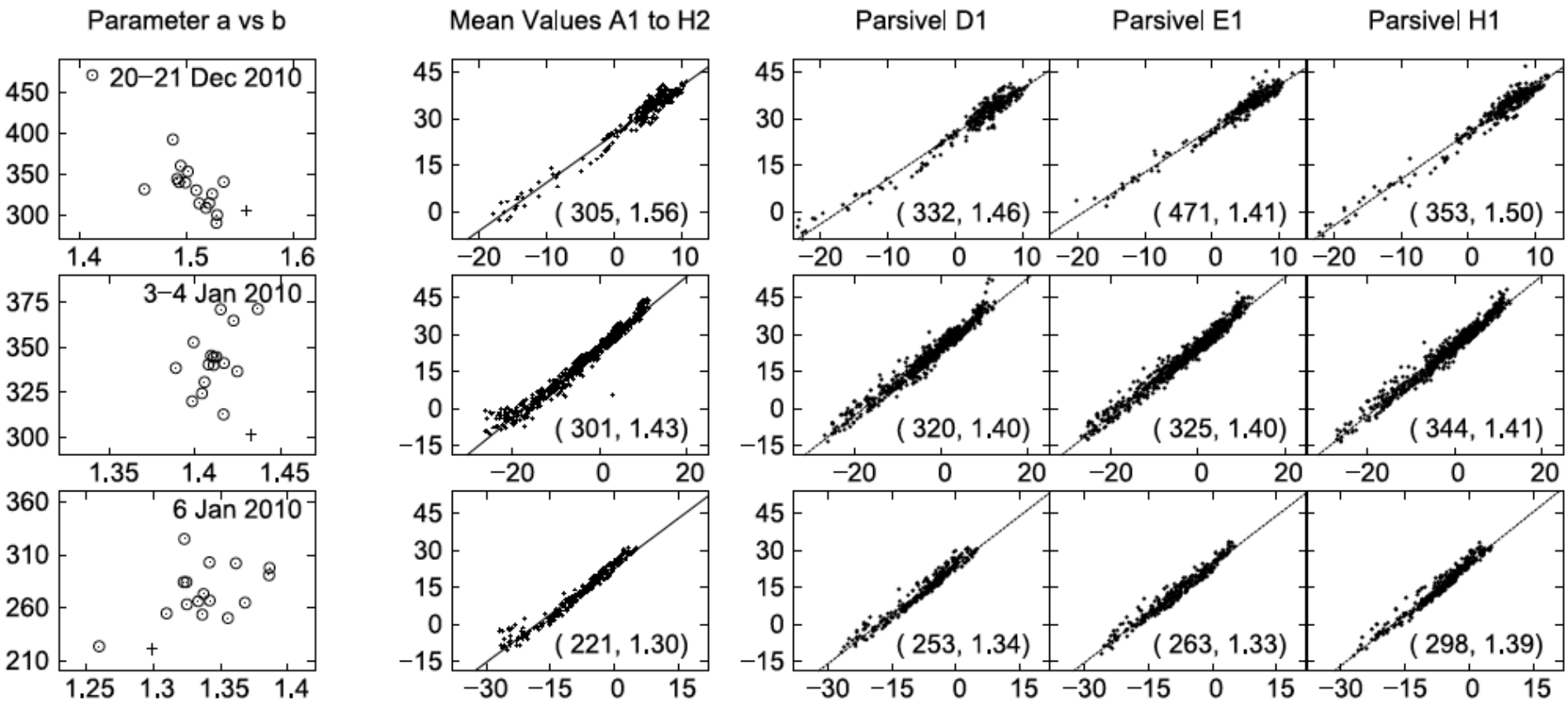
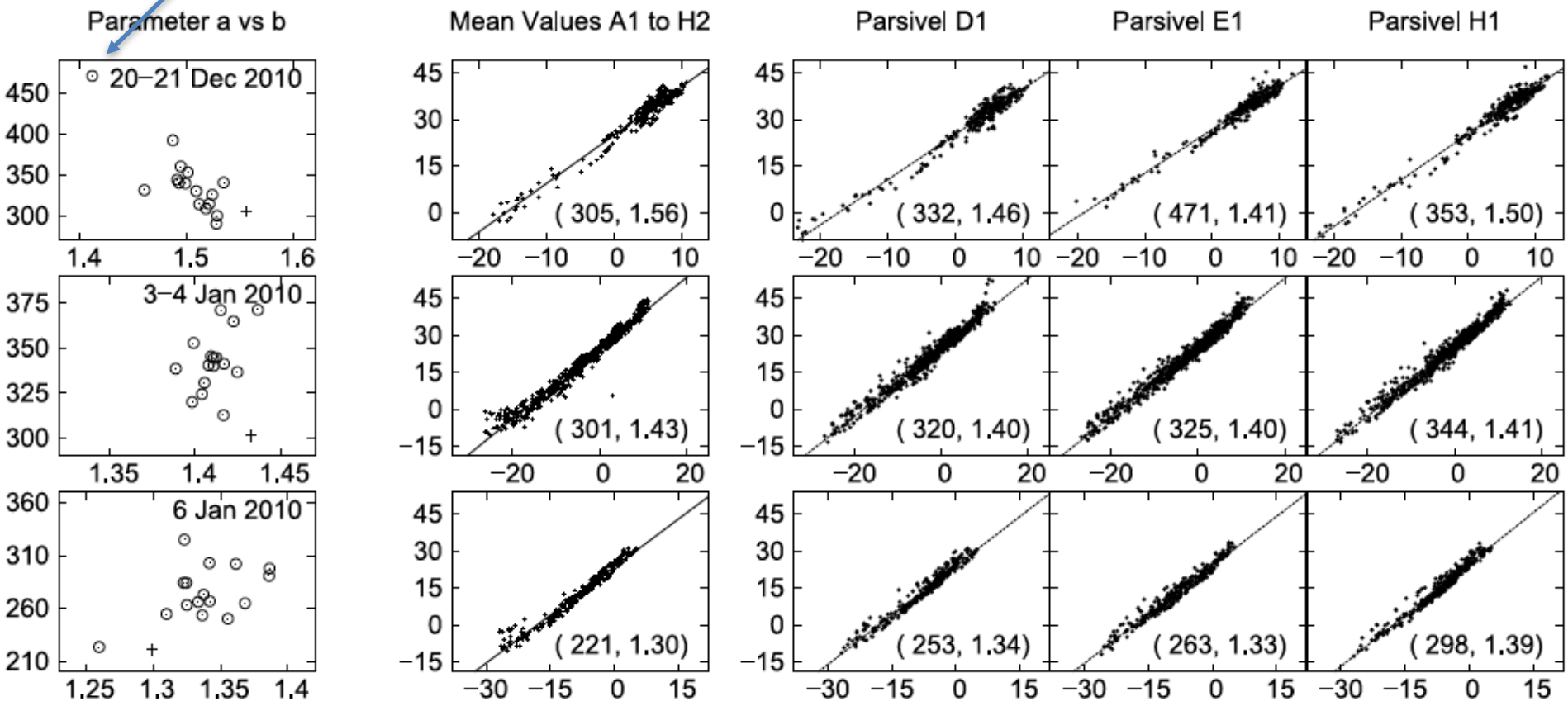

Parameter a vs b
Mean Values A1 to H2
Parsivel D1
Parsivel E1
Parsivel H1
20–21 Dec 2010
3–4 Jan 2010
6 Jan 2010
(305, 1.56)
(332, 1.46)
(471, 1.41)
(353, 1.50)
(301, 1.43)
(320, 1.40)
(325, 1.40)
(344, 1.41)
(221, 1.30)
(253, 1.34)
(263, 1.33)
(298, 1.39)

outlier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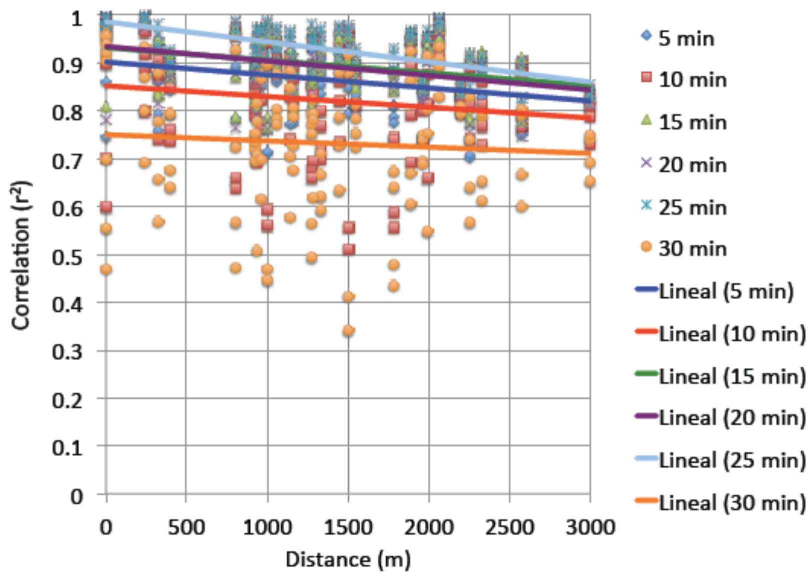
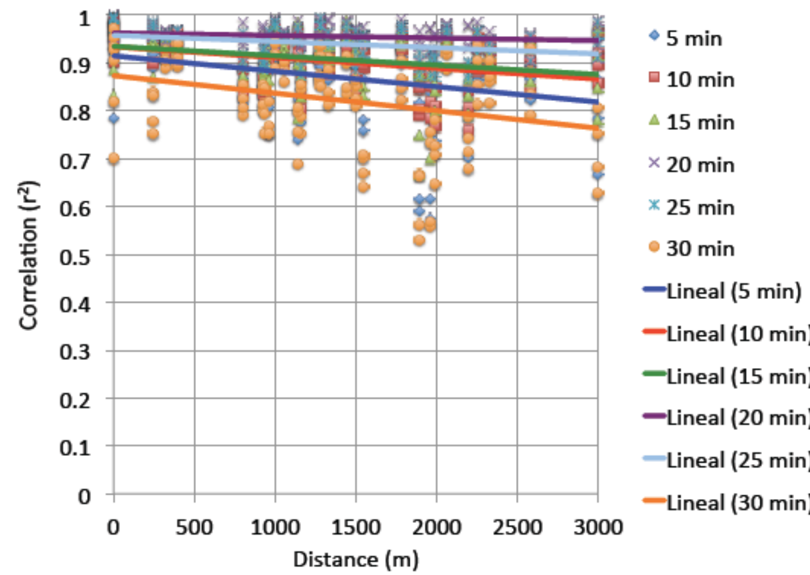
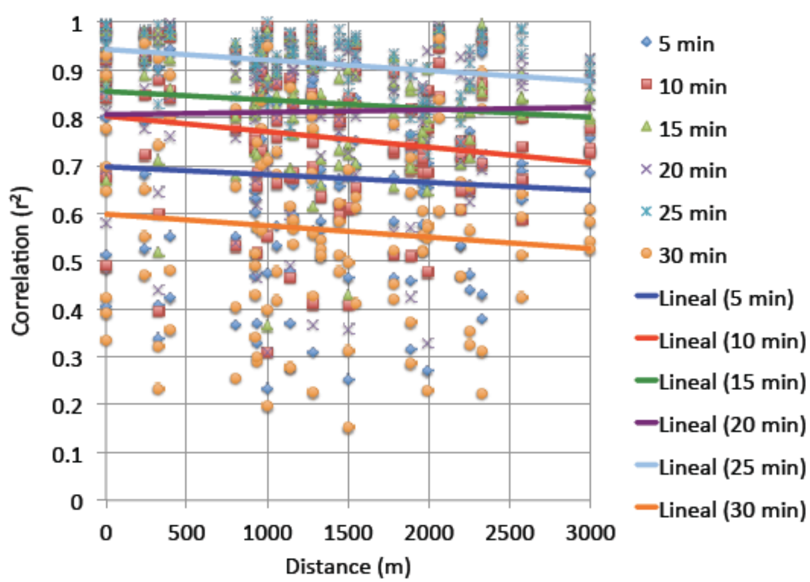
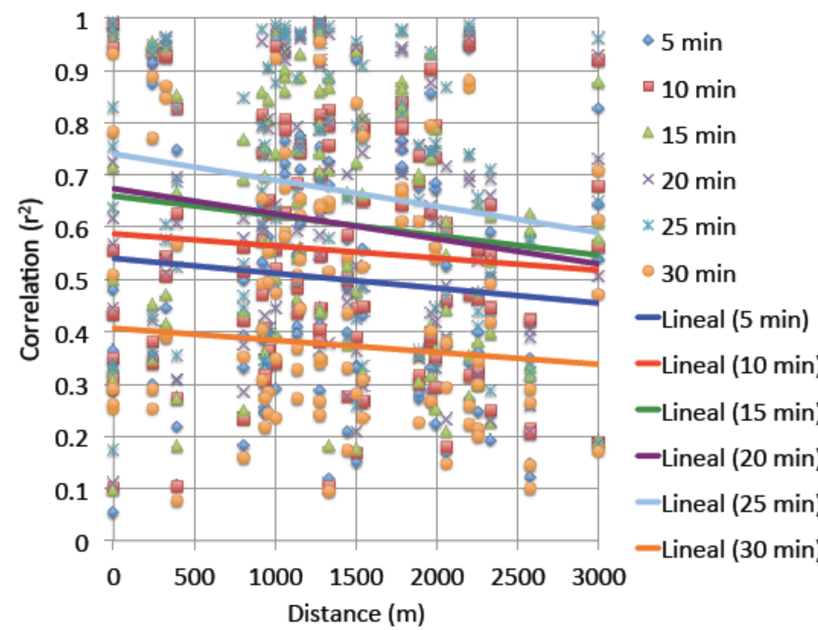
Reflectivity (Z)









Parsivel[1] + Parsivel[2]

2015

Parsivel[2] improves over Parsivel[1]

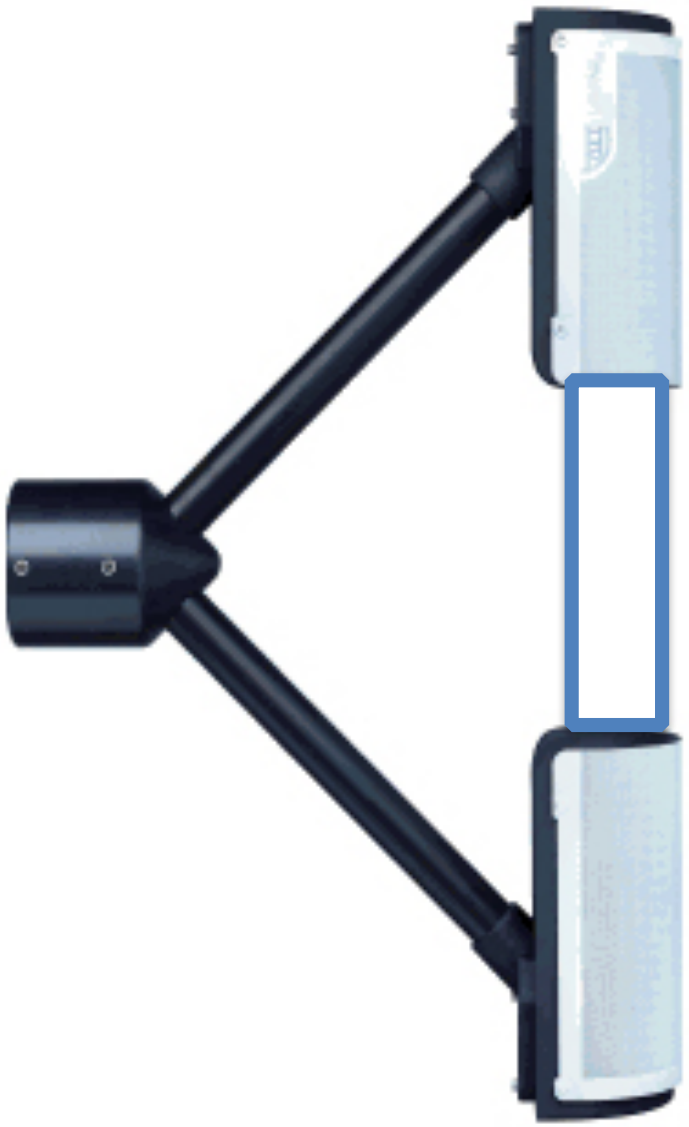
[more sensitive to small drops]

The 'Large Disdrometer Experiment'

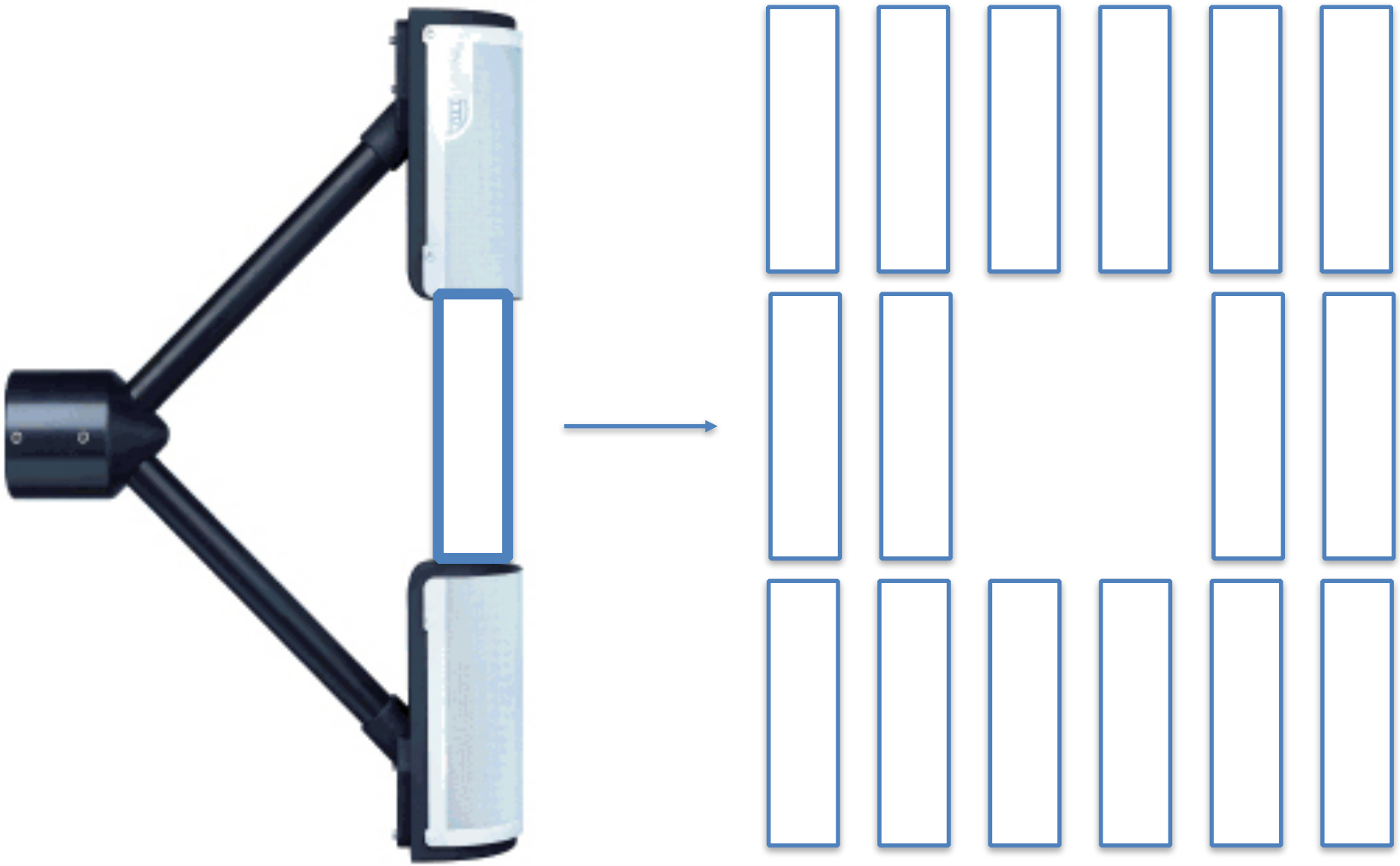
How important is the small catching area of disdrometers? Large biases?

How large should it be?

LDE
2011



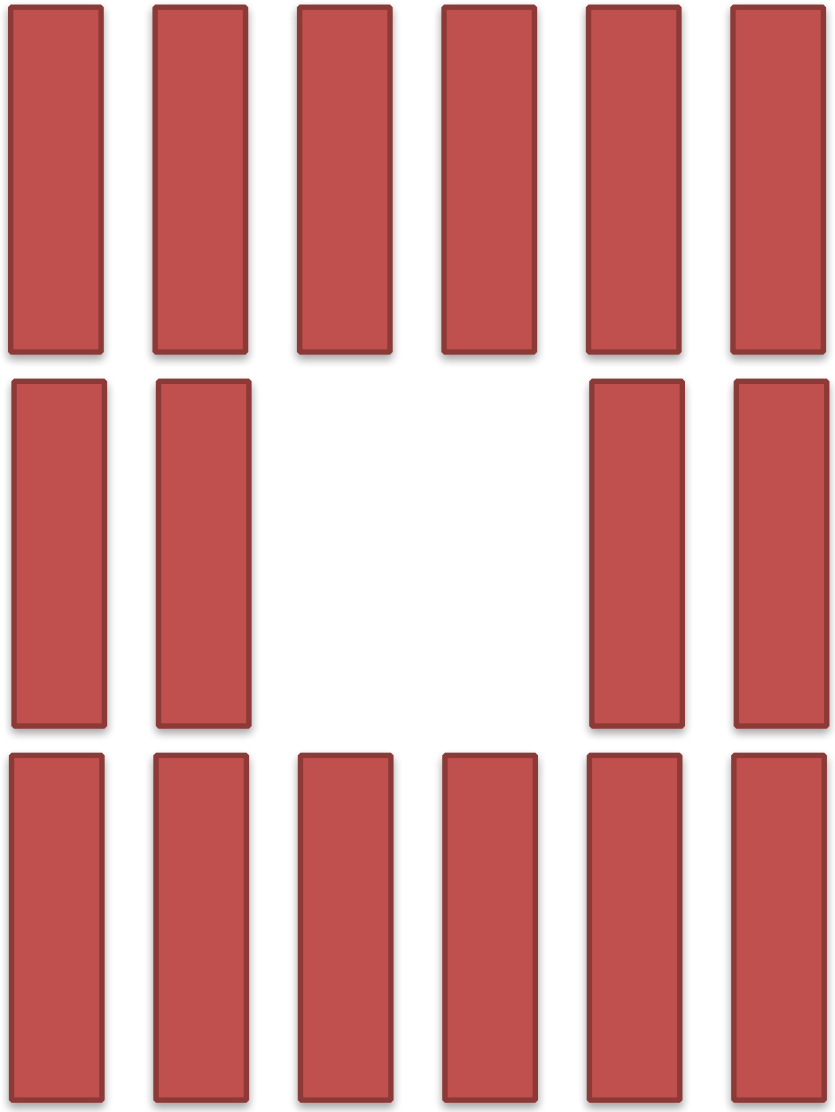
Experimental layout

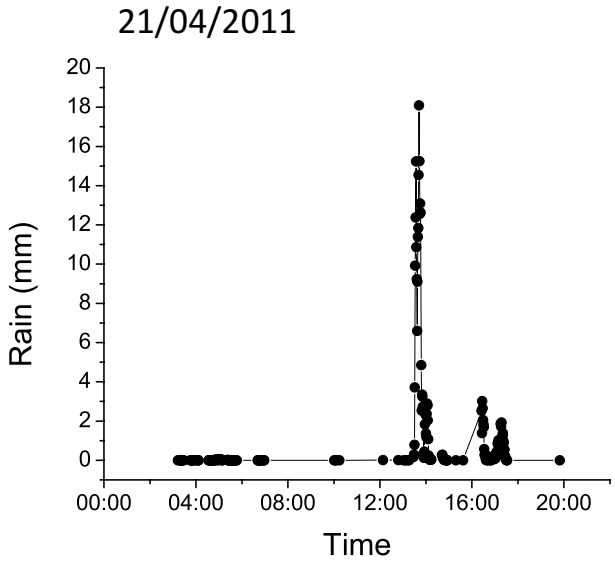


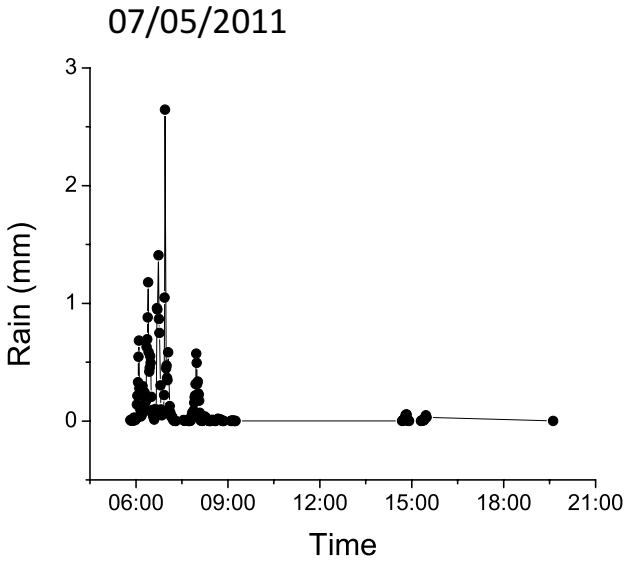
The catching area is larger: increased probability of having rare events (large drops)

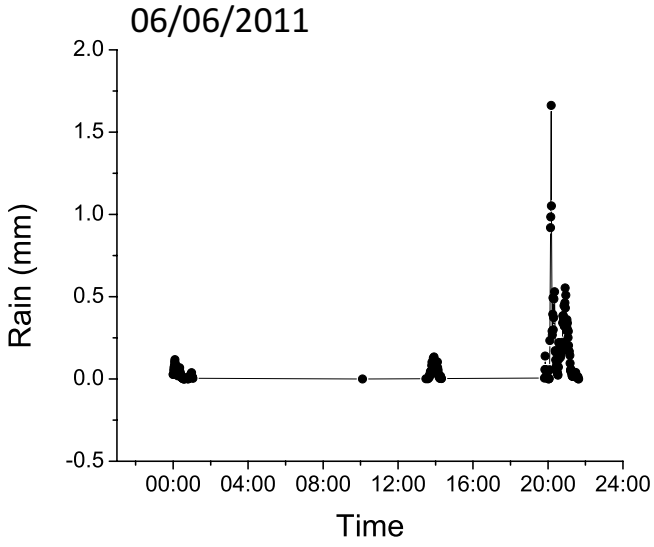
Assumption: Estimates are going to be closer to the truth than those from just one disdrometer

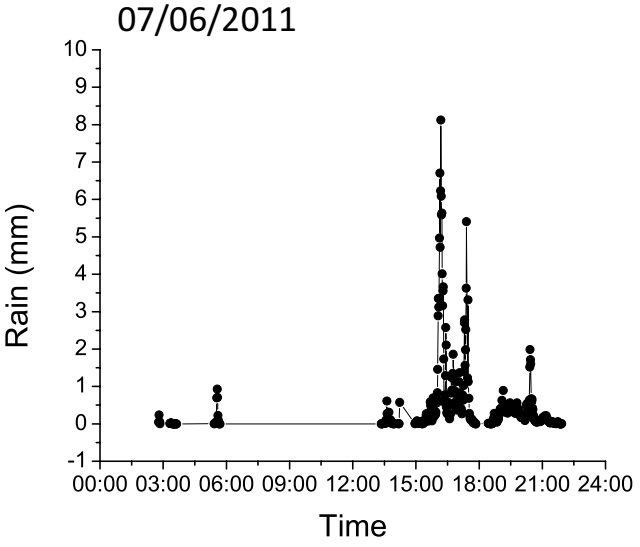
The synthetic LD acts here as a reference: our “true” estimate of the DSD




21/04/2011
Rain (mm)
Time
00:00
04:00
08:00
12:00
16:00
20:00

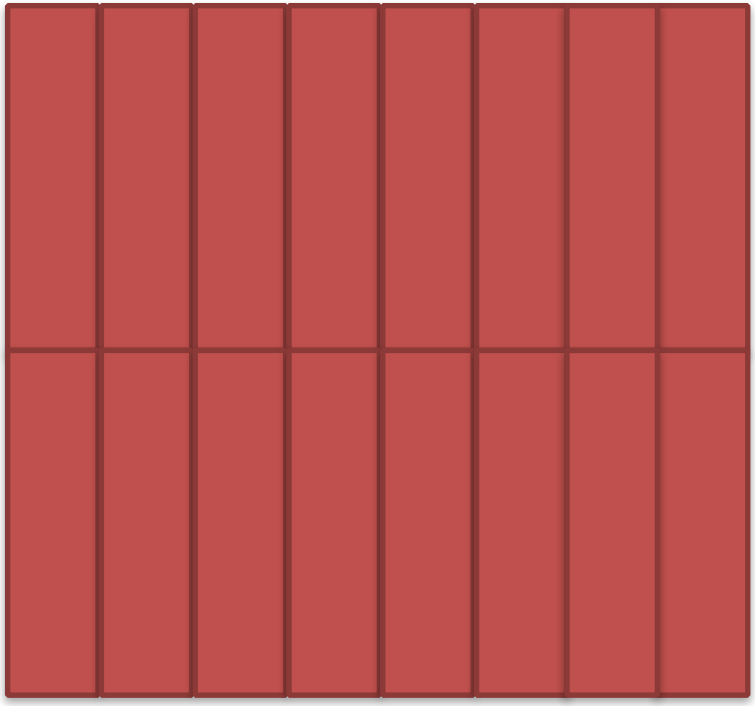

07/05/2011
Rain (mm)
Time
06:00
09:00
12:00
15:00
18:00
21:00


06/06/2011
Rain (mm)
Time
00:00
04:00
08:00
12:00
16:00
20:00
24:00


07/06/2011
Rain (mm)
Time
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00

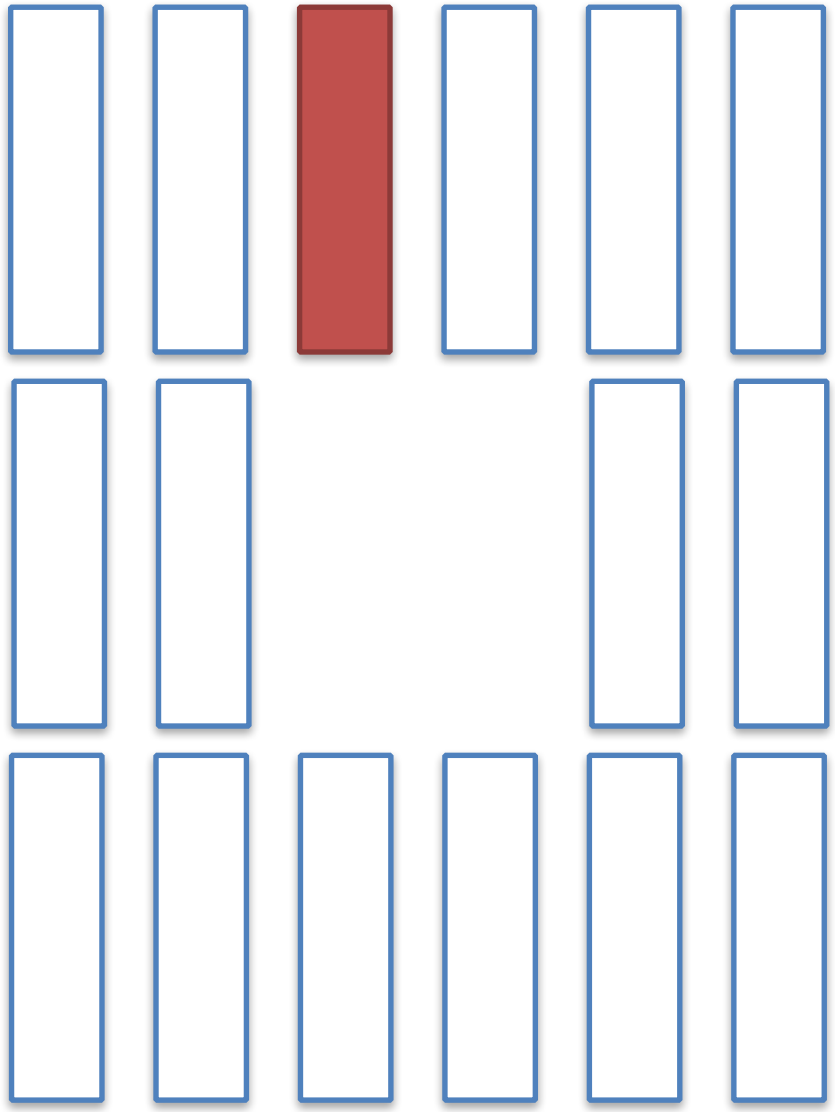
One disdrometer

Large-Disdrometer
(LD) equivalent area



What if we have one?

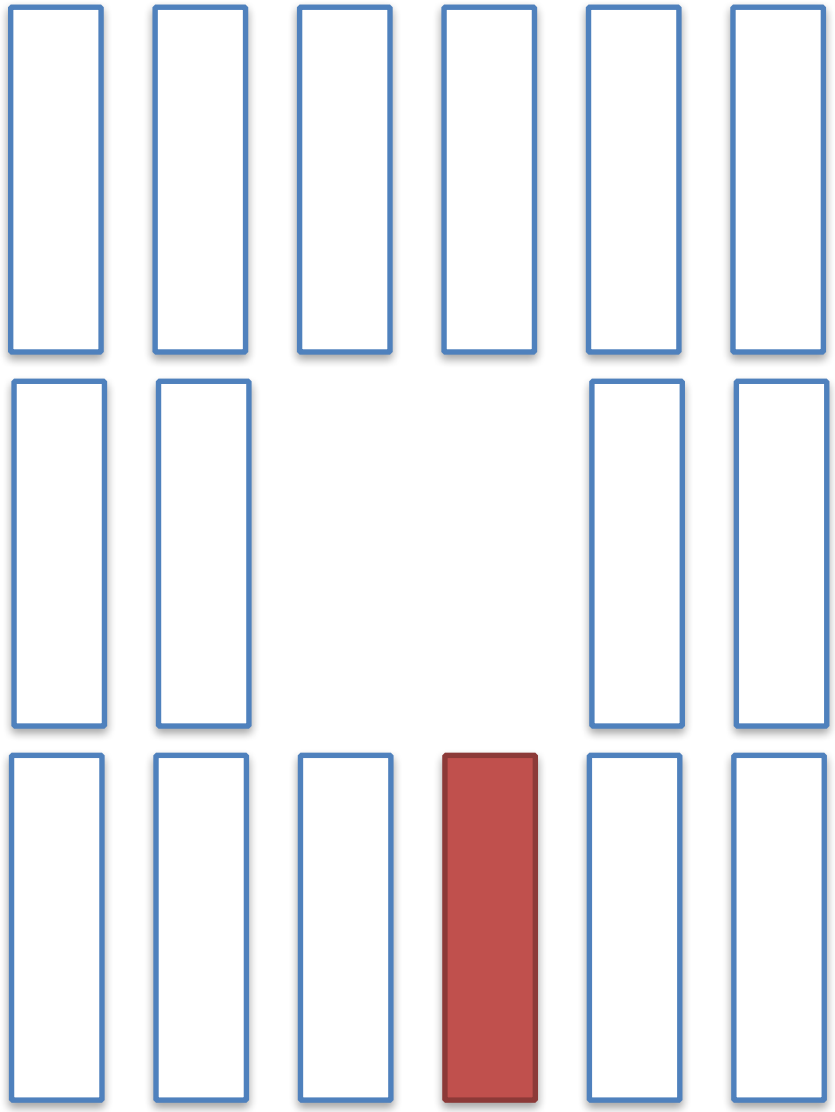
That would give us a different answer from the LD



What if we have another one?

That would also give us a different answer

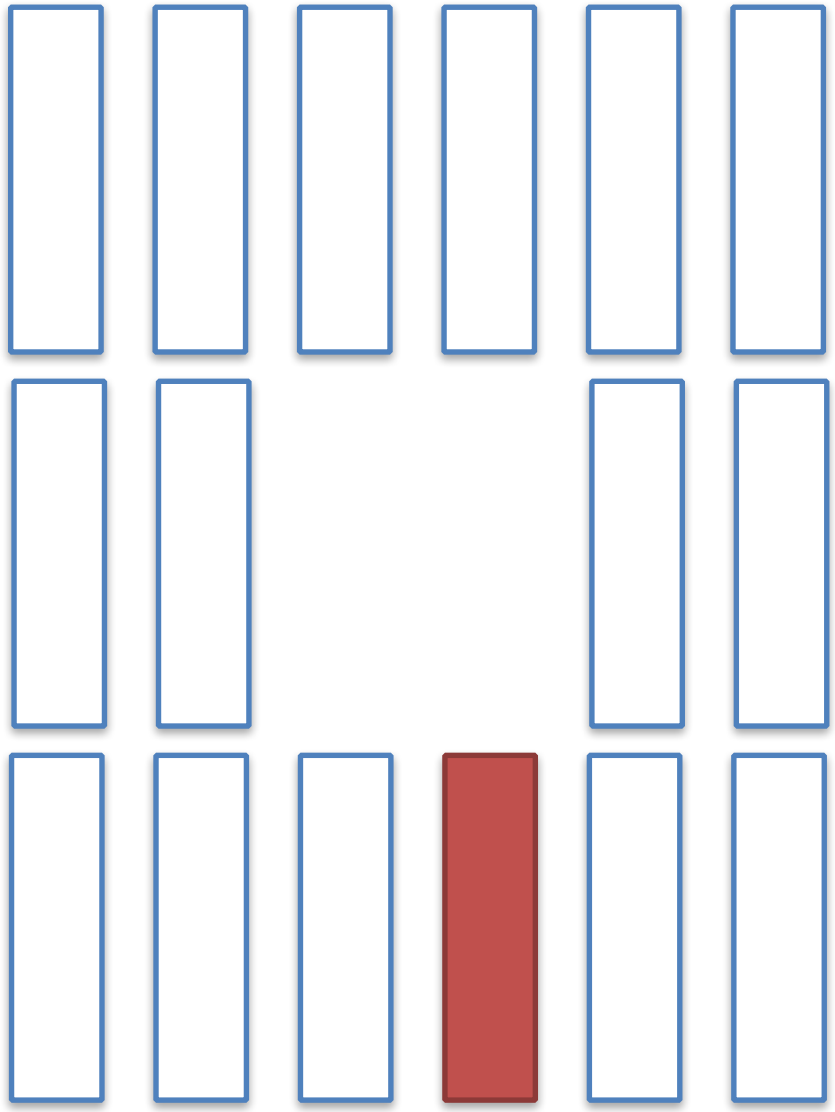
Different from the first, and also from the LD estimate



What if we have another one?

That would also give us a different answer

Different from the first, and from the LD estimate

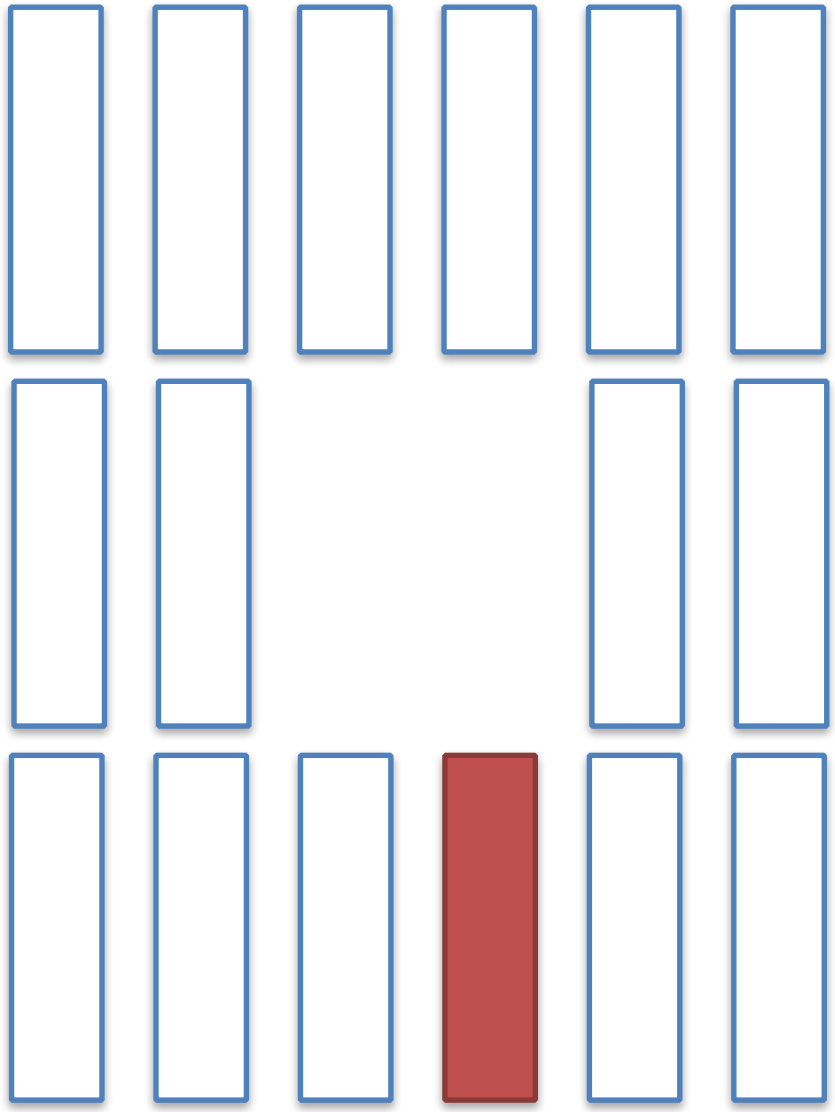


For r=1, we have 16 arrangements

Cause we have $\binom{n}{r}$ (”n choose r”)

arrangements of r disdrometers
taken from a set of n disdrometers

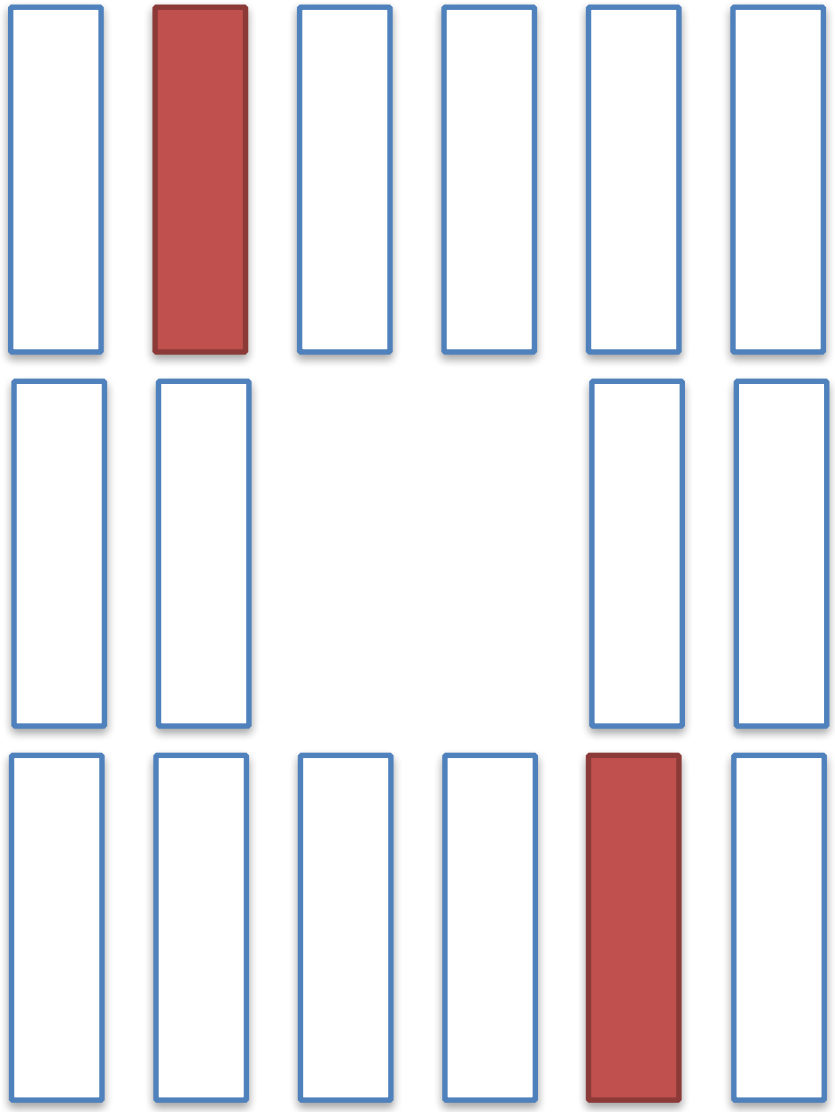
(also noted as C_r^n)



What if we have two?

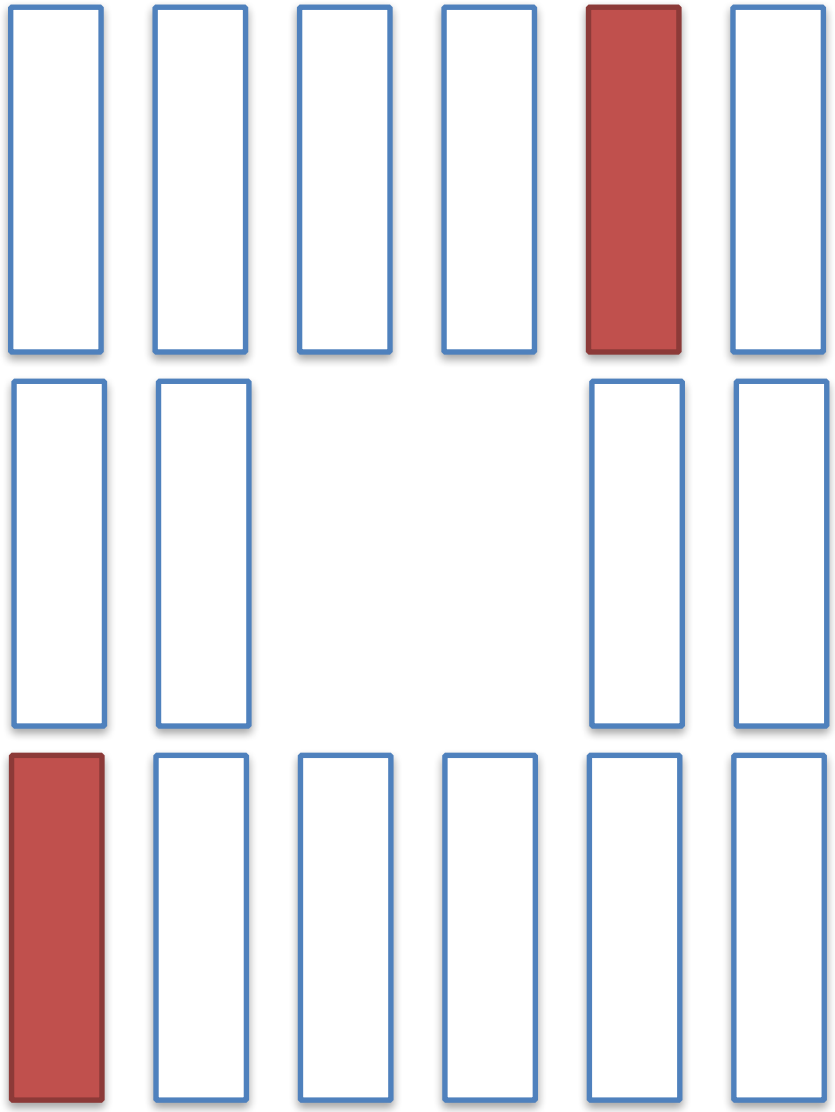
That would give us a different answer

Different from just one, and different from the LD-reference



What if we have two?

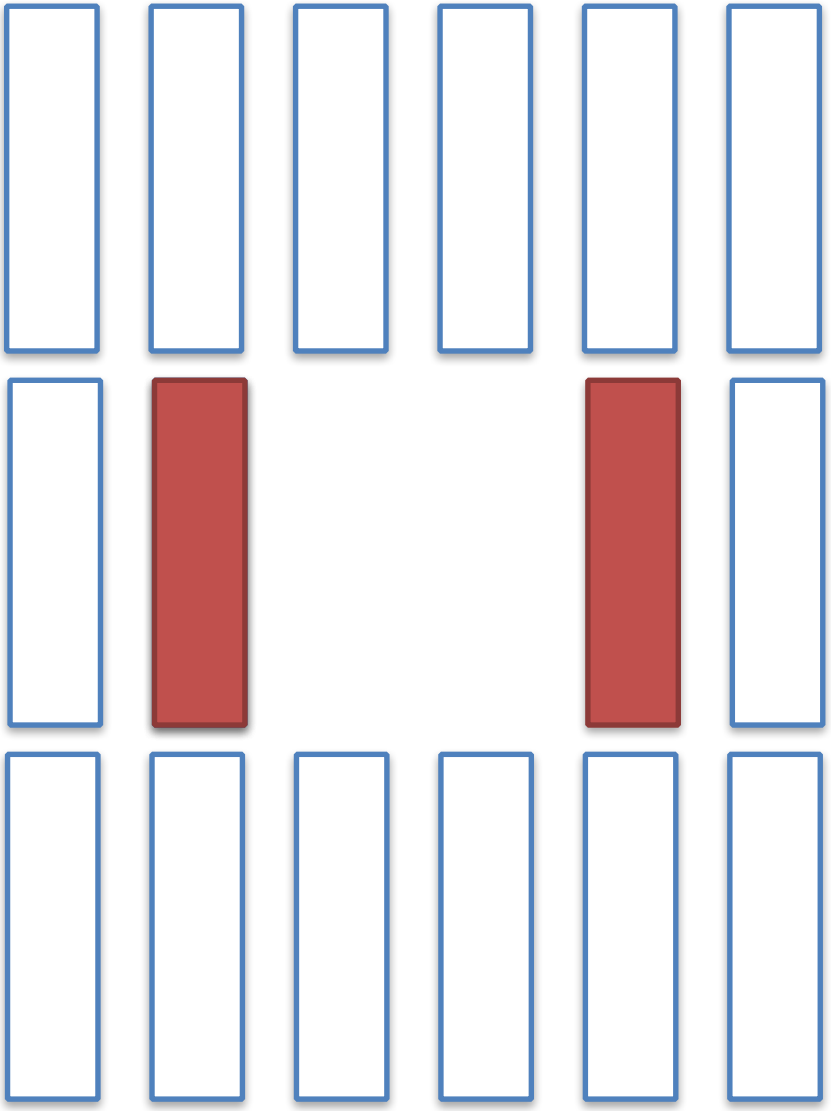
Same thing for other arrangements



What if we have two?

That would give us a different answer

We have 16!/(14!·2!) = 120 combinations

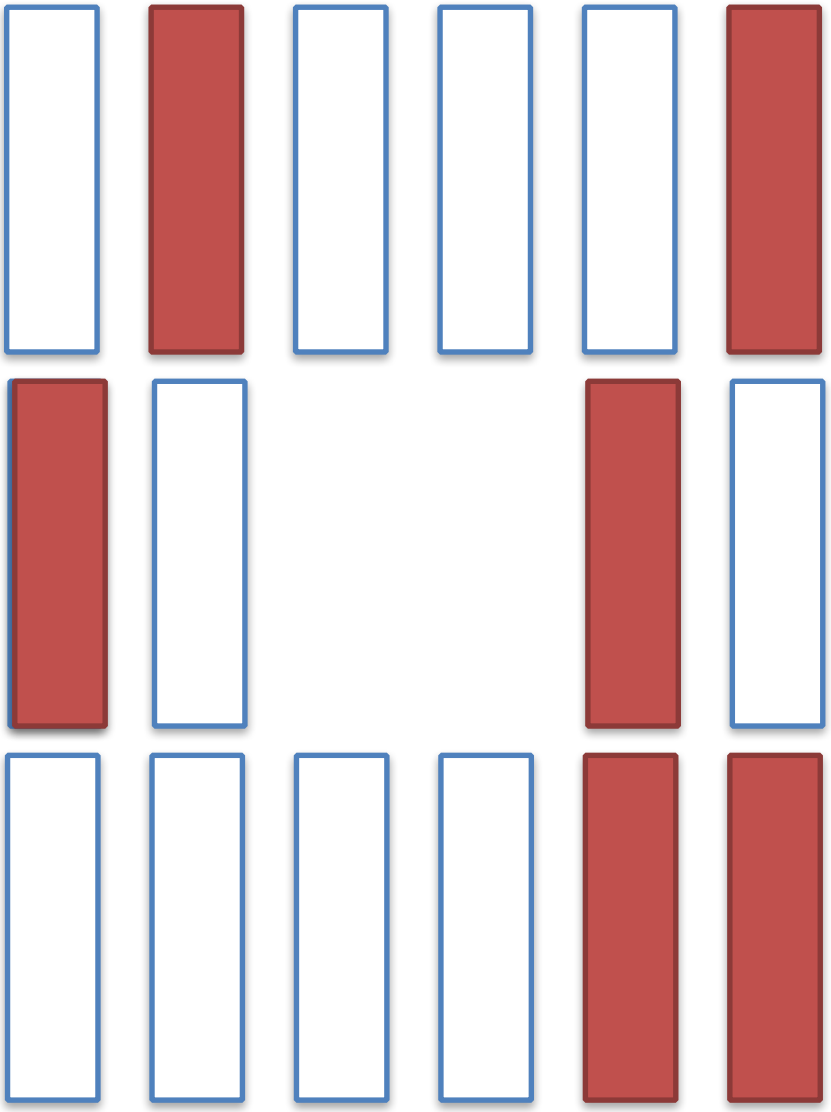


What if we have six?

That would indeed give us a different answer

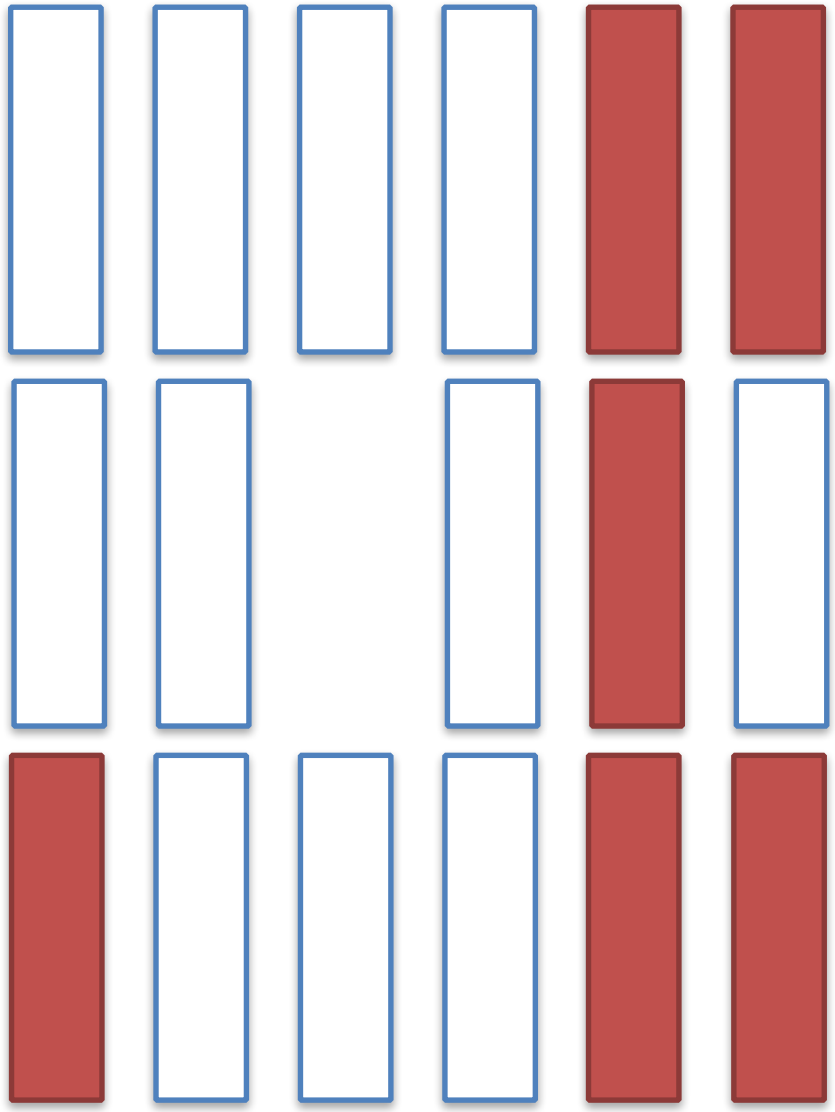
We have now 8008 combinations

But this answer is likely to be closest to the 'truth' than having just two



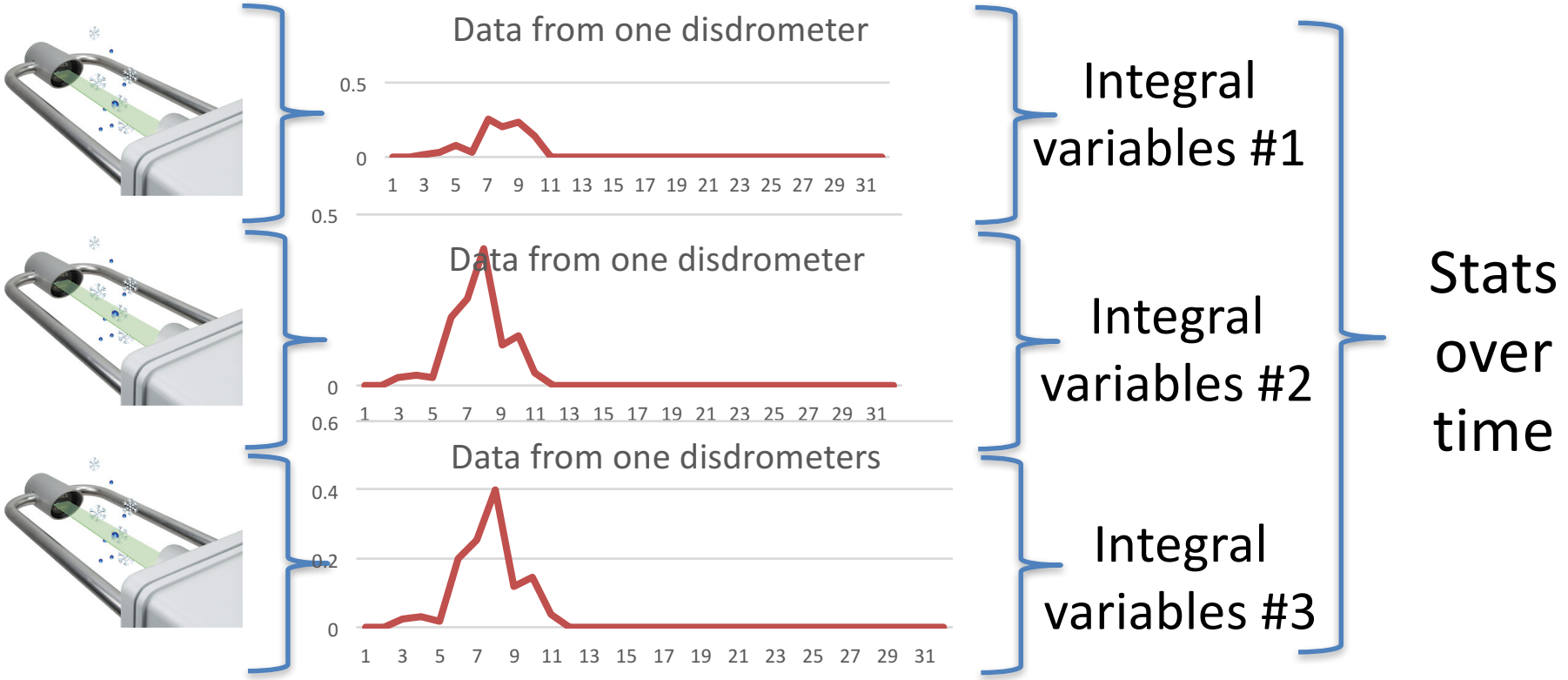
In total, we calculated 16k different estimates

We **didn't** randomly selected a setup, we calculated all the possible combinations.



Of course we did not just aggregate the results from individual disdrometers

We **didn't** do this:



Of course we did not just aggregate the results from individual disdrometers

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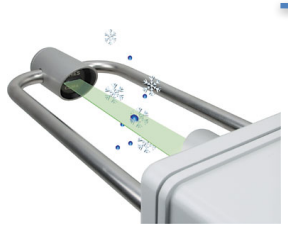
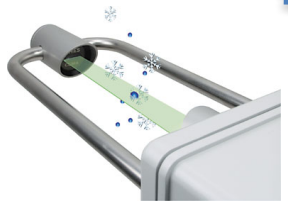
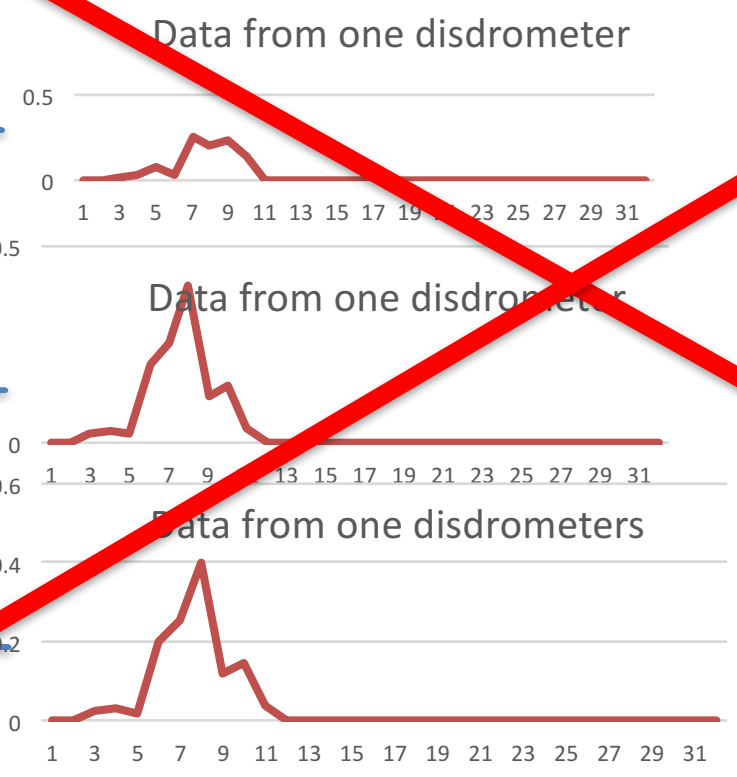






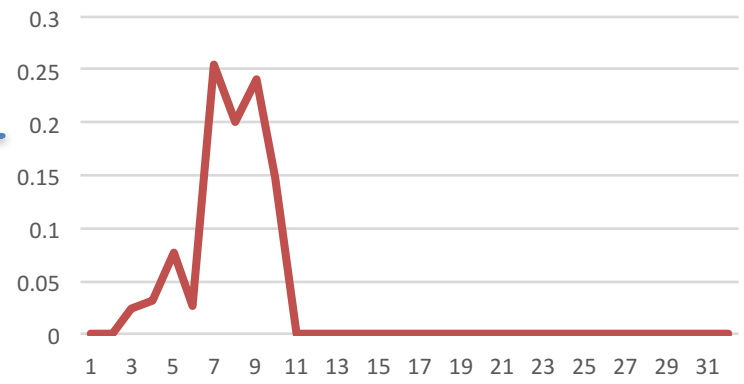
Integral variables #1

Integral variables #2

Integral variables #3

Stats over time

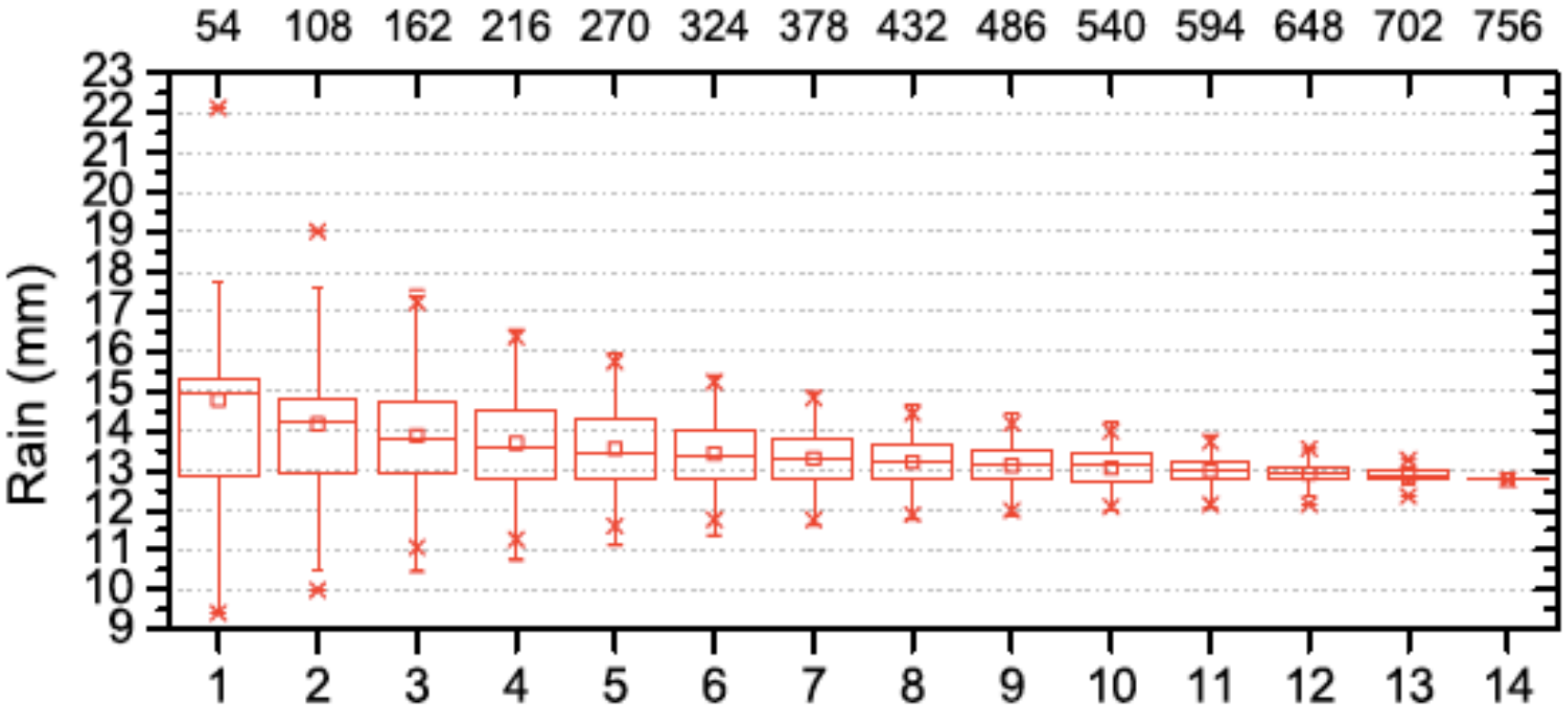
We rather input the processing software (Tokay's) with the data of the **union** of data from several disdrometers then calculate the mean values over the combinations, over time

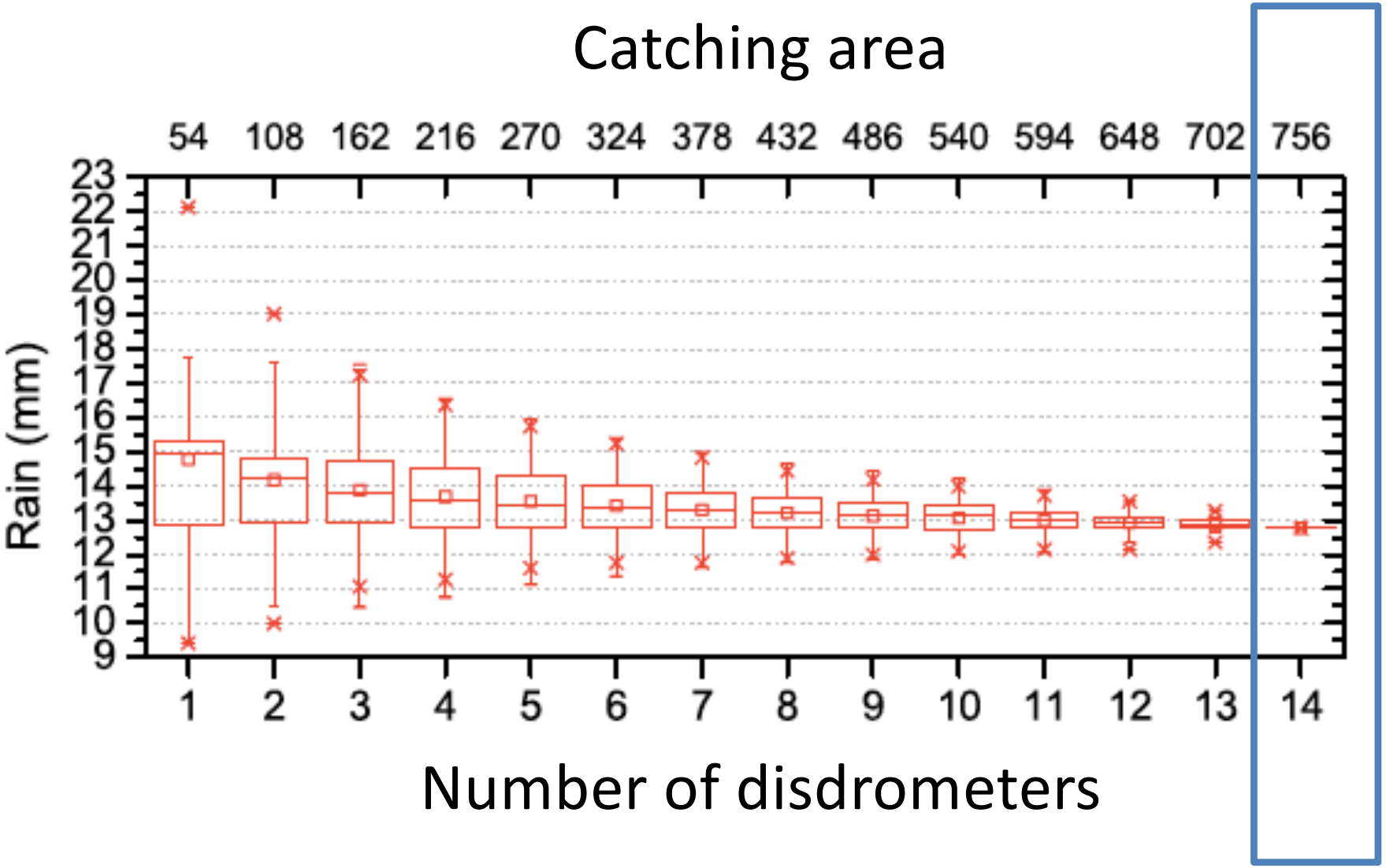


Integral variables #1 U #2 U #3

Stats over time

Catching area



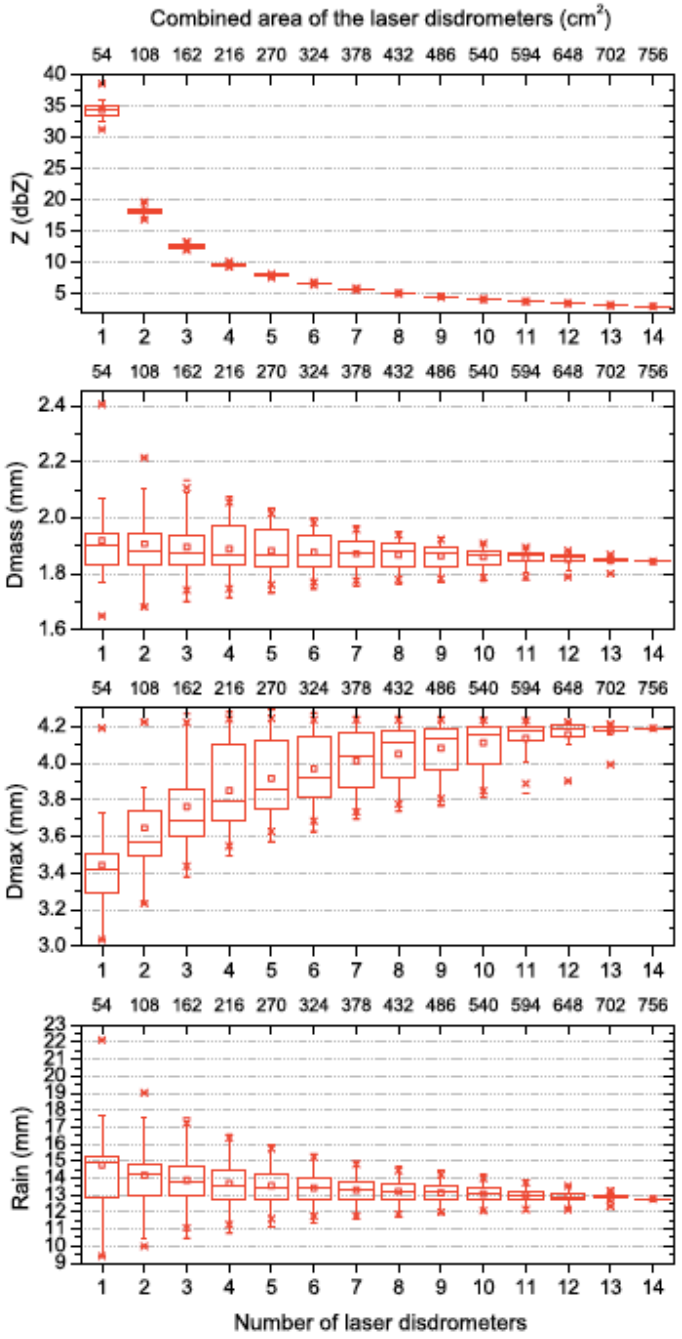

Catching area
54 108 162 216 270 324 378 432 486 540 594 648 702 756
Rain (mm)
23 22 21 20 19 18 17 16 15 14 13 12 11 10 9
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Number of disdrometers

A single disdrometer almost certainly:

- Underestimates Z
- Overestimates R
- Overestimates D_{mass}
- Underestimates D_{max}

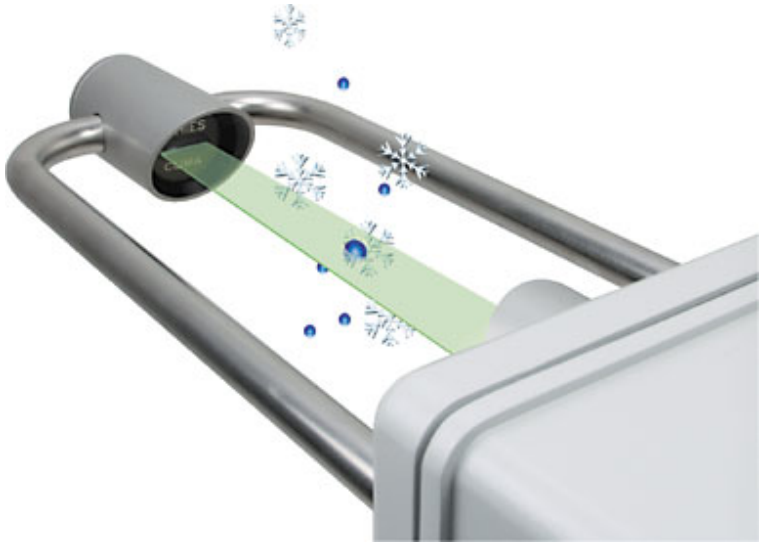
This is something we should be aware of when considering the values given by a single instrument

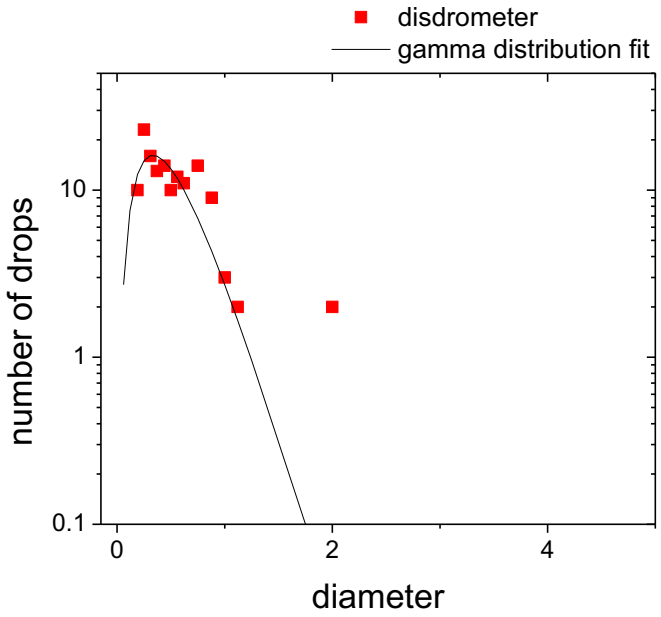
The combined area of 7 disdrometers seems enough for this case

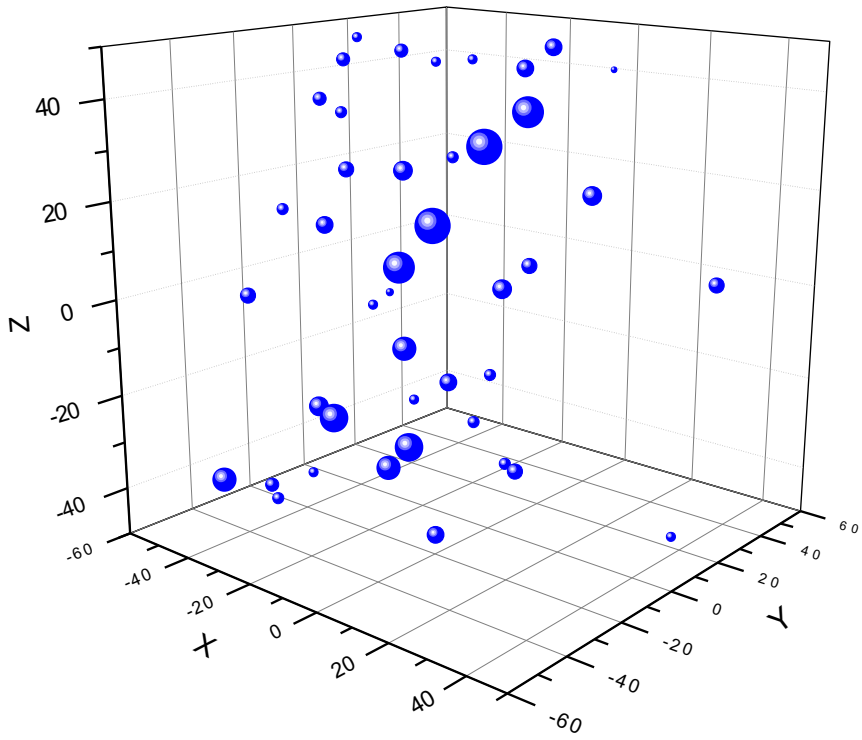


There is of course other sources of error/uncertainty

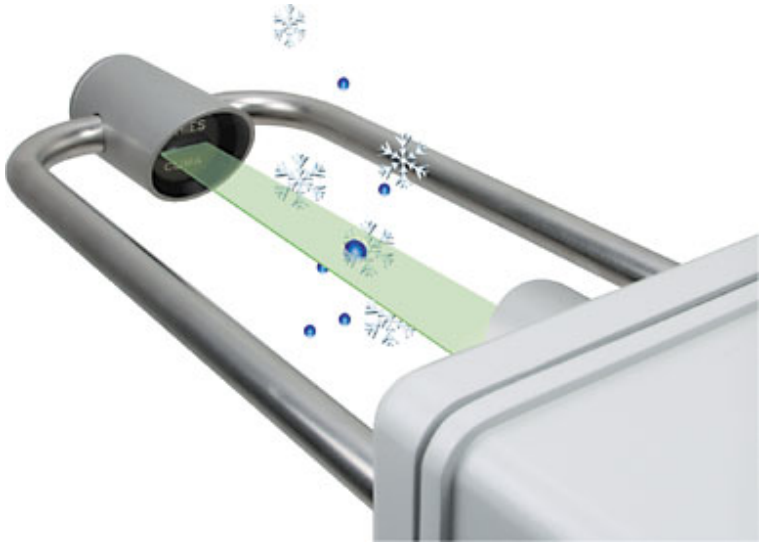
Thus for instance in calculating radiometric quantities

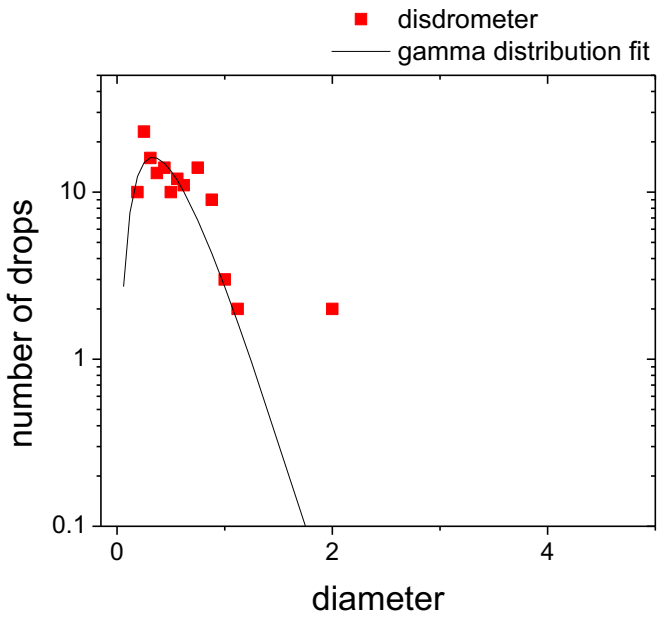


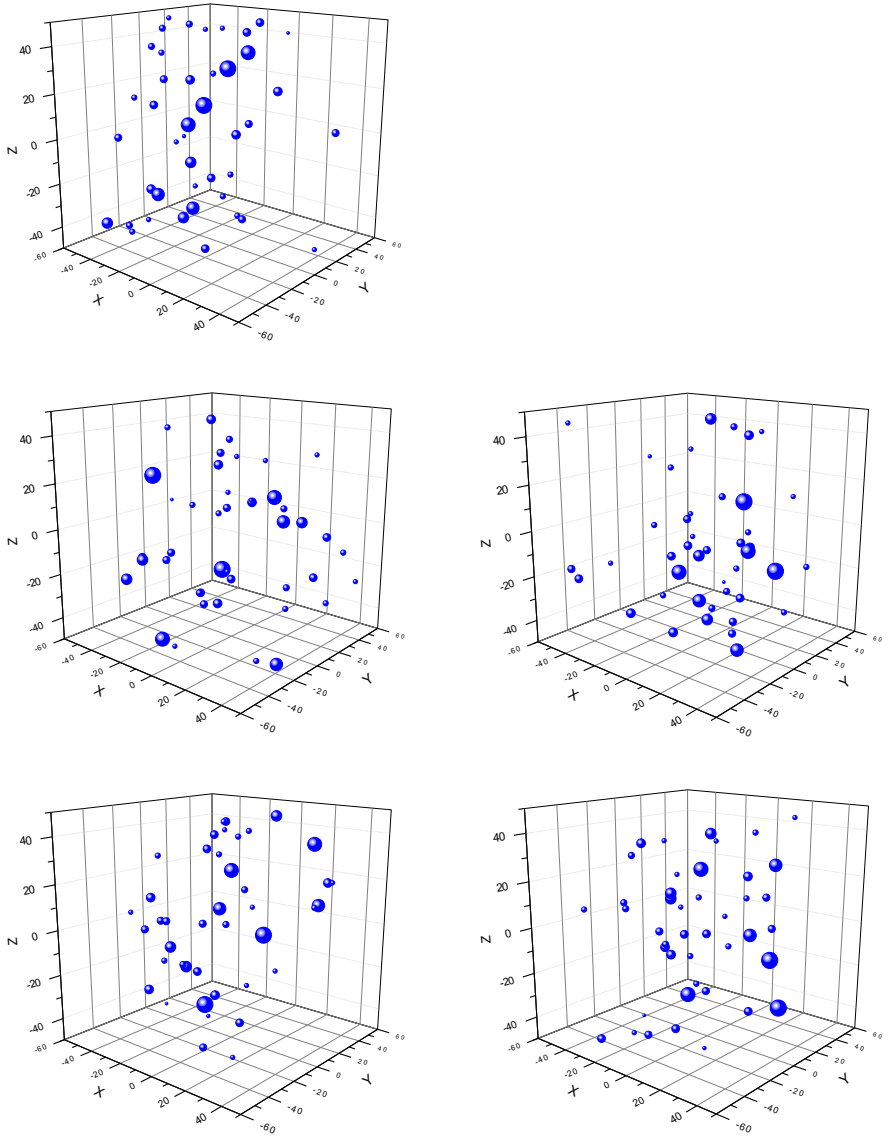




[spherical drops; drop size is exaggerated in these plots]

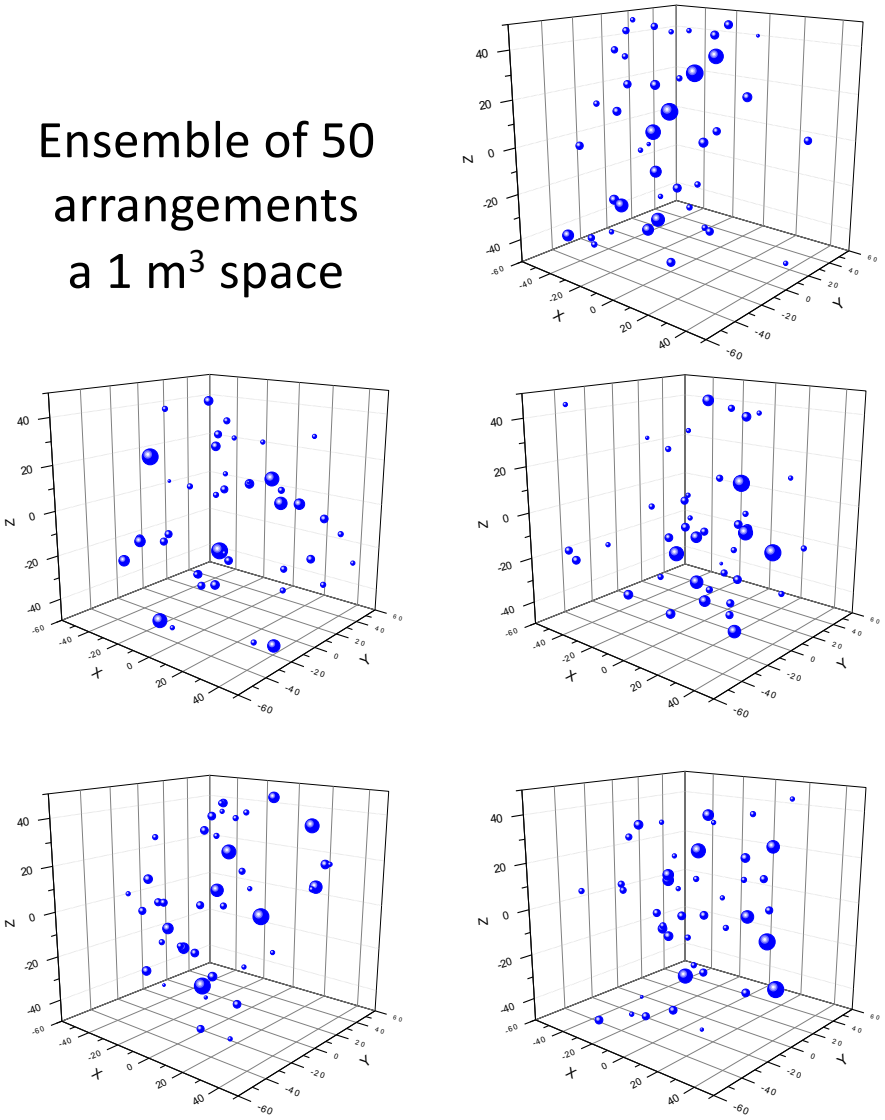






[spherical drops; drop size is exaggerated in these plots]

Ensemble of 50 arrangements a 1 m^3 space



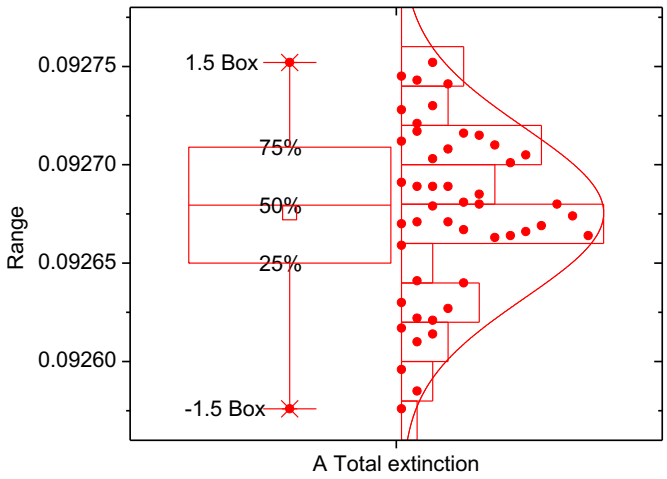
T-matrix multiple scattering calculations for a variety of arrangements, frequencies and temperatures

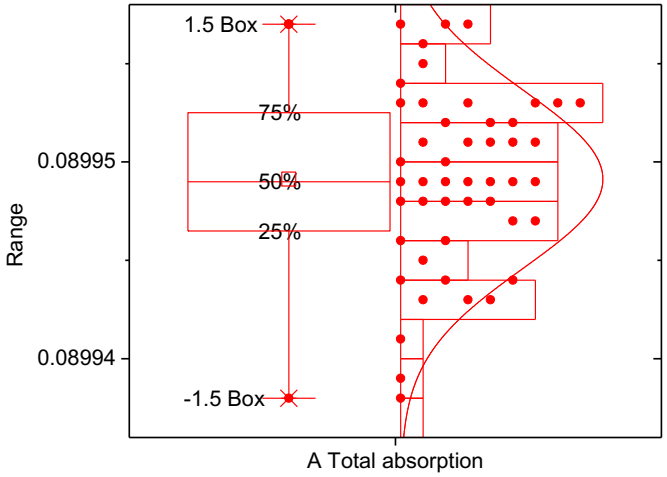
· Complex refractive index depends on temperature, (salinity) and frequency

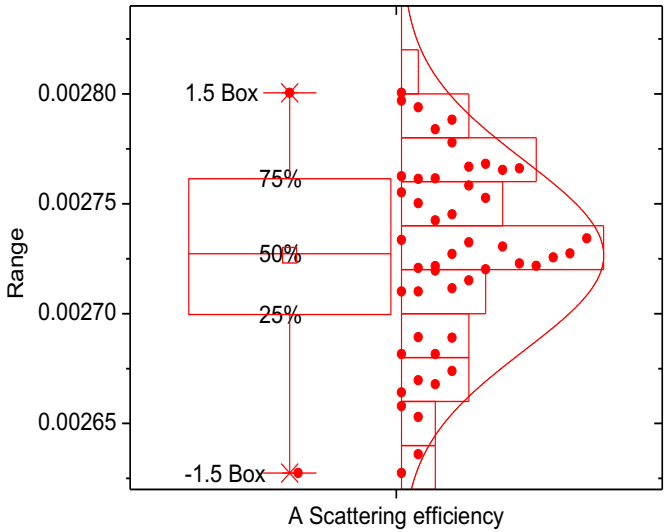
· Length scale factor depends on frequency

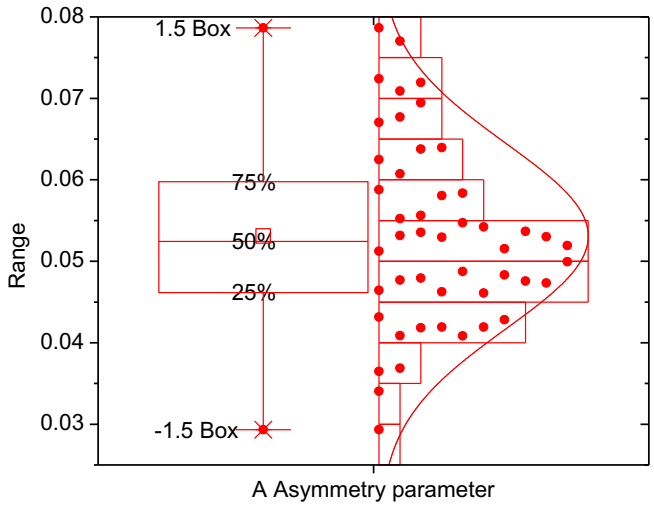
X-band; 5 ºC

Spread of radiometric quantities within the ensemble (same DSD)



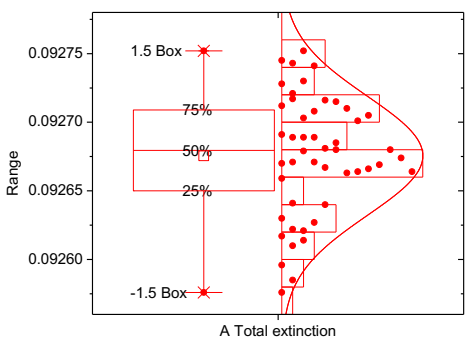


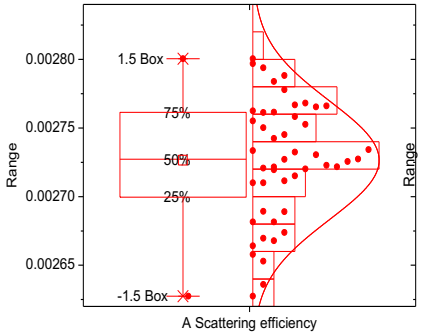


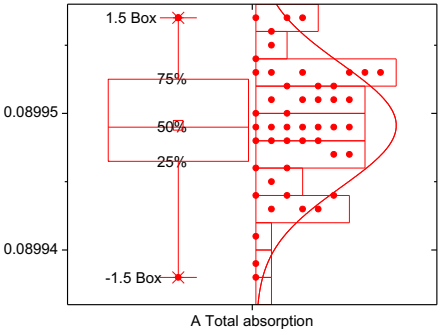


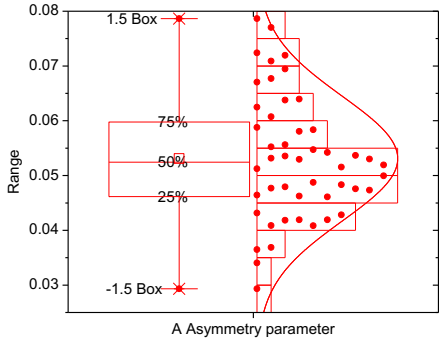
X-band; 5 ºC

CASE A

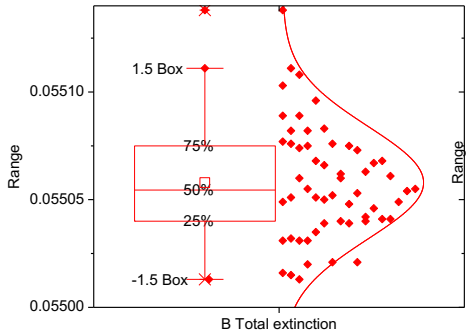


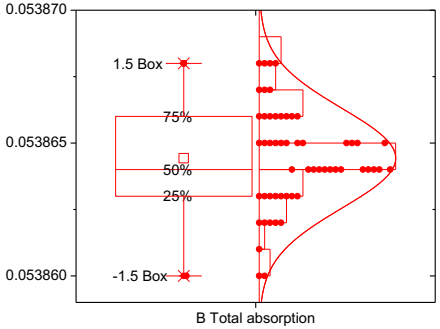


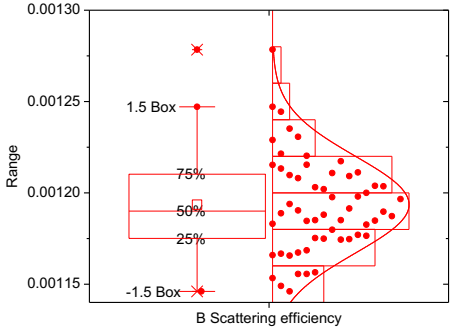


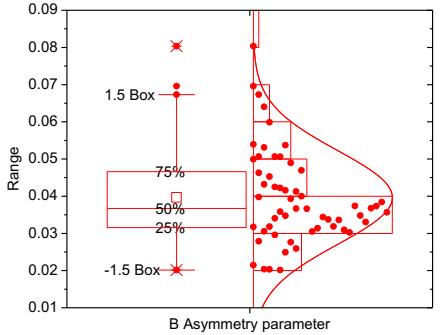


CASE B









UCLM's T-Rex

A dual polarization X-band radar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UCLM
UNIVERSIDAD DE CASTILLA-LA MANCHA

Transmitter (Magnetron type)
featuring:
- Frequency range: ***9.375 GHz (X-Band)***
- Nominal RF Peak Power > 55 kW
- Pulse modes: 3
- Pulse Width: 0.33 μs - 3.3 μs

SELEX METEOR 60DX TYPE

RF Receiver Unit
featuring:
- Frequency range 9.3 - 9.5 GHz (X-Band)
- Noise figure < 2.5 dB
- RX total dynamic range > 90 dB
- Dual polarization, H + V simultaneous


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ess
T-ReX
UCLM
Transportable
Research
X-band radar
www.earthphysics.net

[Blame Walt]

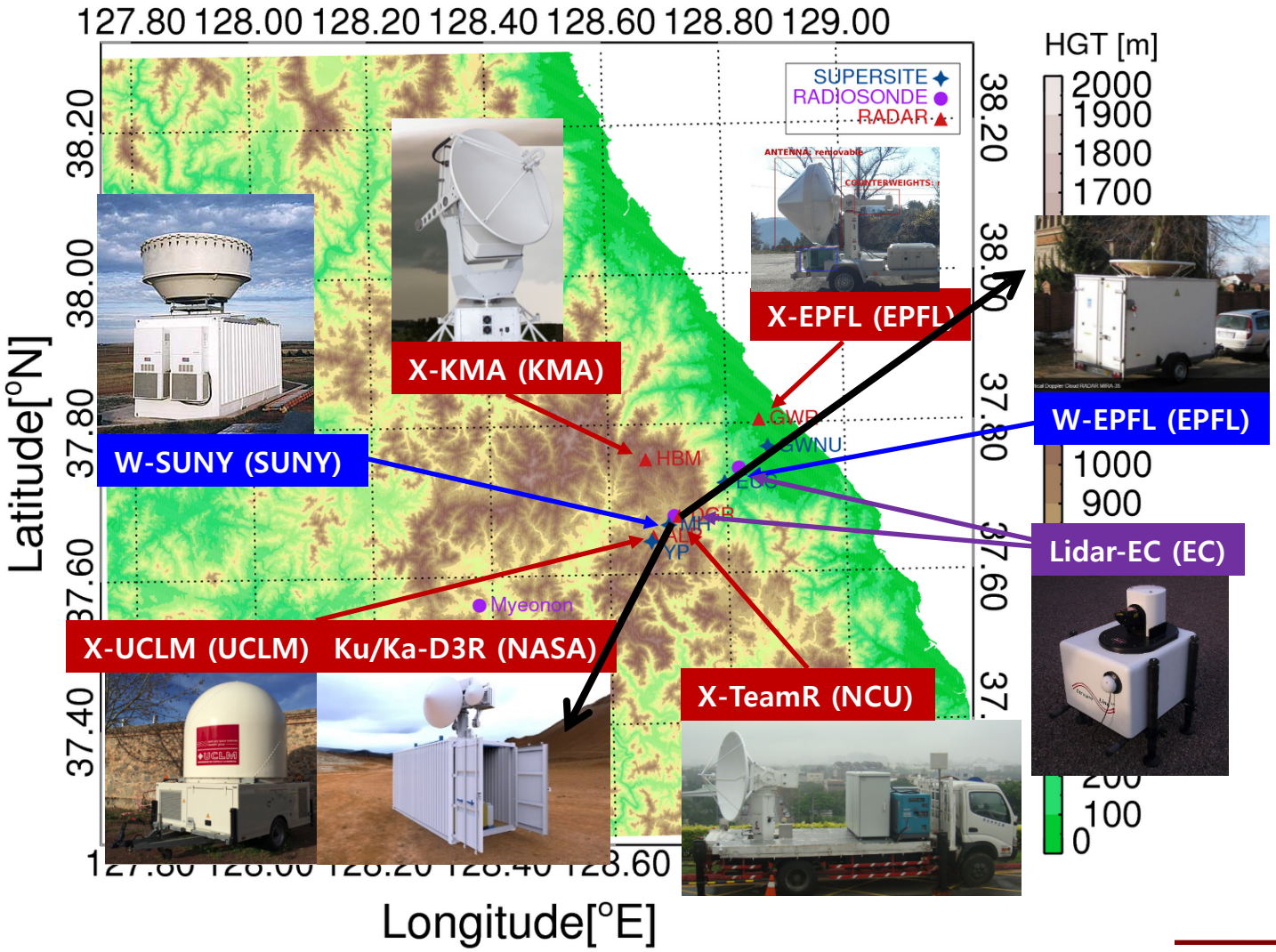
T-Rex at Wallops

New (received December 2015)

Now at Wallops

We hope we can start measuring by next week

ICE-POP 2018 [slide from G. Lee]



Thanks